ELECTRICAL REVIEW

ILLUSTRATED.

A WEEKLY JOURNAL OF

Electric Light, Power, Telephone, Telegraph and Scientific Progress.

VOL. 18, No. 22. WEEKLY. | NEW YORK, SATURDAY, JULY 25, 1891. | $3 per annum. Single Copies, 10 Cents.

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Entered at Post Office, New York, as Mail Matter of the Second Class.

VIEWS, NEWS AND INTERVIEWS.

President Harrison has appointed William E. Simonds, of Connecticut, Commissioner of Patents, *vice* Charles E. Mitchell, resigned.

Since the publication of Nikola Tesla's paper on alternate currents of high frequency, the brilliant inventor has accumulated a mass of interesting correspondence which will require many weeks to answer. Mr. Tesla requests his correspondents to be patient.

Will this scheme work? Try it, some one, and learn: Go down cellar where stands your furnace, worth as much to you during these hot days as a dead man's hand, and disconnect the one or more hot air pipes leading from the top of the furnace up through the house. Now connect another tin pipe to the hot air pipes and carry it to one of the cellar windows. Here install a fan run by an electric motor. Set her going, and if she works, you will be able to hang your hat up on any one of the furnace gratings in your house walls. A suction of air will be maintained and you will possess more drafts than ever you had before. This would be a novel and extremely comforting use of the electric fan, which ought to recompense a house owner for the needed outlay.

M. Secrétan, formerly director of the Societe des Metaux, the great French copper ring, who was condemned to six months' imprisonment, has been pardoned after six weeks' incarceration.

Pure platinum is now selling at $12 per ounce. The demand is fairly good.

A countryman from a considerable distance back entered an Atlanta restaurant and proceeded to make himself at home by hanging his coat on the electric motor that whirled the fans. This stopped the motor and threw off the belt. The countryman had washed his face at the water cooler and was preparing to wipe it on the dangling belt when the proprietor came along and took him in charge.—*New York Sun.*

The Boston *Herald* says that "the statements regarding the cost of municipal lighting, made by those who are urging our cities and towns to adopt systems of electric lighting under public auspices, must be taken with a number of grains of allowance. We do not mean to say that these assertions are intentionally dishonest; but the subject is so complicated that it is exceedingly easy to prepare an exhibit which is perfectly correct, so far as it goes, and yet entirely misleading if presented as a fair average of outgo."

Drs. McDonald and Ward have rendered their report to the warden of Sing Sing prison regarding the late electrocutions. The report thus winds up:

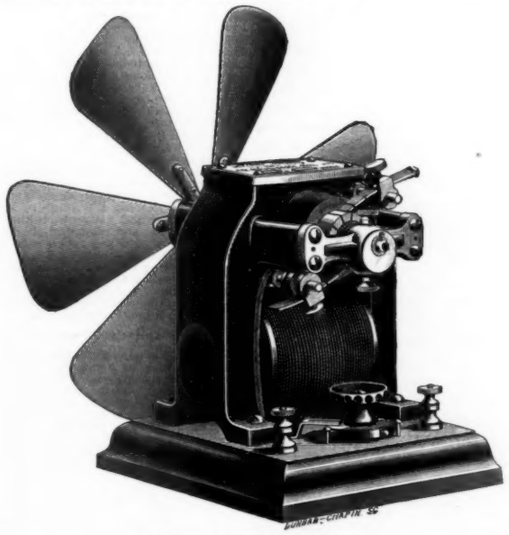
"In concluding, allow us to congratulate you on the completeness, in all their details, of all your preliminary arrangements, on the uniform good order and decorum which prevailed during the trying ordeal, and on the resulting demonstration of the rapidity and painlessness of this method of inflicting the death penalty.

"The experience of to-day has proved to our satisfaction that this method is superior to any other yet devised."

The Holtzer-Cabot Fan Motor.

The Holtzer-Cabot Electric Company, of Boston, Mass., well known manufacturers of standard electric bells, annunciators and general electrical supplies, have recently added to their already extensive works a department for the manufacture of electric fan motors. We illustrate the Holtzer-Cabot one-eighth horse-power motor with fan on this page, and, basing conclusions on the thoroughly established reputation of its makers for highest grade in every product of their factory, we cannot doubt that the motor is as electrically and mechanically perfect as it is possible to make it.

The machine illustrated has a Norway iron field core with malleable cast pole pieces, a drum armature with a very substantial commutator (nothing but mica insulation being used). It has self-oiling bearings, with phosphor bronze journals, and in mechanical detail is claimed to be more nearly perfect than anything heretofore attempted in the small motor line. It is provided with a switch giving three changes of speed to the fan, and is wound for circuits of any potential. It is heavily japanned and furnished plain or nickel-plated. A drum armature was selected as being more durable and efficient than a ring, it having been decided to sacrifice no feature on account of cost which rendered it possible to obtain greater durability or higher efficiency in the motor.



HOLTZER-CABOT FAN MOTOR.

The company does not believe that the demand of the present day is for a fan motor whose special merit is that it can be easily repaired, but rather that the demand is for one that does not get out of repair, and they have here made one which they are ready to guarantee to be permanently serviceable. Especial attention, however, has been given to making the machine interchangeable in every part, which is true of all apparatus manufactured by this company.

The Holtzer-Cabot Electric Company have secured the services of Mr. E. S. Pillsbury in this department of their works. Mr. Pillsbury has had an extended experience in the line of small electric motor manufacturing, having had employment with both the "C. & C." Motor Company and the Crocker-Wheeler Motor Company, and his connection with this latest produced motor, planned and perfected under his personal supervision, is a guarantee that the Holtzer-Cabot fan motor embodies every excellent feature known in these progressive days.

World's Fair Notes.

West Virginia will erect a $20,000 building at the Exposition.

Chili, although kept pretty busy with a formidable insurrection within its territory, has taken time to decide to participate in the World's Fair, and to appropriate $100,000 for that purpose.

Forty-three mineral producing counties in Georgia, Alabama and Tennessee, in a convention of more than 100 delegates, held at Chattanooga, Tenn., have decided to make a tri-state exhibit at the World's Fair.

Illinois has appropriated $800,000 for its exhibit at the Exposition. It will erect an immense building, costing about $350,000, and endeavor to make the most complete exhibit of any of the States. The State Board of Agriculture has charge of the matter.

Chief Buchanan has sent out letters to all of the State Boards of Agriculture, advising them as to the design of the proposed Forestry building. The building will be about 200 by 500 feet, and will occupy a commanding position on the lake shore. It will be designed to illustrate in its construction and arrangement the forestry wealth of the world. The architecture is of a rustic character and will make a beautiful effect. A feature will be the wide colonnade along the front of the building and across either end. The supporting columns of this colonnade will be trunks of trees with the bark on, representing the characteristic woods of the United States. This will not only add to the unique beauty of the structure, but will furnish the States an opportunity to show specimens of their trees. These tree trunks will be 25 feet long, about 20 inches in diameter at the base, tapering gradually to the top. Each trunk will have attached to it a tablet on which will be engraved the name of the State furnishing it, the name of the tree, and the estimate of the quantity of such timber in the State or Territory. Chief Buchanan asks each State Board of Agriculture to send on three of such tree trunks.

THE INCANDESCENT LAMP.

The Edison Patent Sustained—The Case Carefully Reviewed—History of Incandescent Lamp Manufacture and Invention.

THE SUBJECT OF CONTROVERSY.

The decision of Judge Wallace, of the United States Circuit Court, rendered on the 14th, in the case of the Edison Electric Light Company *vs.* the United States Electric Lighting Company, closes an important stage of incandescent lamp litigation, resulting in a complete victory for the Edison patent. The importance of the litigation will be appreciated when it is estimated that Judge Wallace's decision, sustaining the patent, unless overruled on appeal, will yield the Edison Company $15,000,000, of which about $2,000,000 a year will come in for the next five years, when the patent will expire. The patent upon which suit was brought was No. 223,898, issued to Thomas A. Edison on January 27, 1880, upon an application filed November 4, 1879. Suits have been brought and decided upon the same subject-matter in Great Britain and Germany. In the former country the contest was between the Edison and Swan United Edison Light Company *vs.* Woodhouse & Rawson, and the Edison and Swan United Edison Light Company *vs.* Holland *et al*, in both of which cases the Edison interests ultimately triumphed. In Germany an attack was conducted in the form of a petition to annul the German patent, which resulted favorably to the Edison interests; but in a subsequent suit the Swan lamp was held not to infringe the Edison patent. Mr. Edison's right to the incandescent lamp invention was considered in a prior controversy in this country in a suit of the Consolidated Electric Light Company *vs.* the McKeesport Light Company, for infringement of the Sawyer-Man patent, the broad claims of which were directed to an arch-shaped incandescing conductor made of carbonized fibrous textile material and an incandescing conductor formed of carbonized paper; these claims were allowed after a protracted interference controversy in the United States Patent Office. This suit resulted in a victory for the Edison Company, Justice Bradley holding that the Sawyer-Man patent was too broad in view of the state of the art.

The claims of the patent upon which infringement is alleged cover an incandescing filament of carbon of high resistance secured to metallic leading-in wires, and a carbon filament connected with conductors leading through an exhausted receiver made entirely of glass. The scope of these claims seem to cover every commercial form of incandescent lamp, and in being sustained, evidently gives the Edison Company a monopoly of the lamp industry. In the engraving, Fig. 5 (page 287), on the extreme right, is illustrated the drawings filed by Mr. Edison with his application, and the following is the text of his patent:

THE PATENT.

The object of this invention is to produce electric lamps giving light by incandescence, which lamps shall have high resistance, so as to allow of the practical subdivision of the electric light.

The invention consists in a light-giving body of carbon wire or sheets coiled or arranged in such a manner as to offer great resistance to the passage of the electric current, and at the same time present but a slight surface from which radiation can take place.

The invention further consists in placing such burner of great resistance in a nearly perfect vacuum, to prevent oxidation and injury to the conductor by the atmosphere. The current is conducted into the vacuum-bulb through platina wires sealed into the glass.

The invention further consists in the method of manufacturing carbon conductors of high resistance, so as to be suitable for giving light by incandescence, and in the manner of securing perfect contact between the metallic conductors or leading wires and the carbon conductor.

Heretofore light by incandescence has been obtained from rods of carbon of one to four ohms resistance, placed in closed vessels, in which the atmospheric air has been replaced by gases that do not combine chemically with the carbon. The vessel holding the burner has been composed of glass cemented to a metallic base. The connection between the leading wires and the carbon has been obtained by clamping the carbon to the metal. The leading wires have always been large, so that their resistance shall be many times less than the burner, and, in general, the attempts of previous persons have been to reduce the resistance of the carbon rod. The disadvantages of following this practice are, that a lamp having but one to four ohms resistance cannot be worked in great numbers in multiple arc without the employment of main conductors of enormous dimensions, that, owing to the low resistance of the lamp, the leading wires must be of large dimensions and good conductors, and a glass globe cannot be kept tight at the place where the wires pass in and are cemented; hence, the carbon is consumed, because there must be almost a perfect vacuum to render the carbon stable, especially when such carbon is small in mass and high in electrical resistance.

The use of a gas in the receiver at the atmospheric pressure, although not attacking the carbon, serves to destroy it in time by "air-washing," or the attrition produced by the rapid passage of the air over the slightly coherent highly heated surface of the carbon. I have reversed this practice. I have discovered that even a cotton thread properly carbonized and placed in a sealed glass bulb exhausted to one-millionth of an atmosphere offers from 100 to 500 ohms resistance to the passage of the current, and that it is absolutely stable at very high temperatures; that if the thread be coiled as a spiral and carbonized, or if any fibrous vegetable substance which will leave a carbon residue after heating in a closed chamber be so coiled, as much as 2,000 ohms resistance may be obtained without presenting a radiating surface greater than three-sixteenths of an inch; that if such fibrous material be rubbed with a plastic composed of lamp black and tar, its resistance may be made high or low, according to the amount of lamp black placed upon it; that carbon filaments may be made by a combination of tar and lamp black, the latter being previously

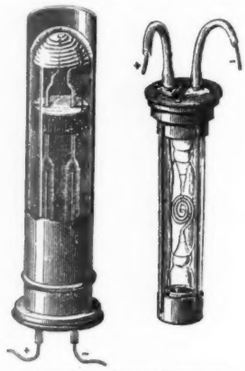


FIG. 1.—GEISSLER TUBES USED FOR MINE LIGHTING, 1867.

ignited in a closed crucible for several hours and afterward moistened and kneaded until it assumes the consistency of thick putty. Small pieces of this material may be rolled out in the form of wire as small as seven one-thousandths of an inch in diameter and over a foot in length, and the same may be coated with a non-conducting non-carbonizing substance and wound on a bobbin, or as a spiral, and the tar carbonized in a closed chamber by subjecting it to high heat, the spiral after carbonization retaining its form.

All these forms are fragile and cannot be clamped to the leading wires with sufficient force to insure good contact and prevent heating. I have discovered that if platinum wires are used and the plastic lamp black and tar material be molded around it in the act of carbonization, there is an intimate union by combination and by pressure between the carbon and platina, and nearly perfect contact is obtained without the necessity of clamps; hence, the burner and the leading wires are connected to the carbon ready to be placed in the vacuum bulb.

When fibrous material is used the plastic lamp black and tar are used to secure it to the platina before carbonizing.

By using the carbon wire of such high resistance I am enabled to use fine platinum wires for leading wires, as they will have a small resistance compared to the burner, and hence will not heat and crack the sealed vacuum bulb. Platina can only be used, as its expansion is nearly the same as that of glass.

By using a considerable length of carbon wire and coiling it, the exterior, which is only a small portion of its entire surface, will form the principal radiating surface; hence, I am able to raise the specific heat of the whole of the carbon, and thus prevent the rapid reception and disappearance of the light, which on a plain wire is prejudicial, as it shows the least unsteadiness of the current by the flickering of the light; but if the current is steady the defect does not show.

I have carbonized and used cotton and linen thread, wood splints, papers coiled in various ways, also lamp black, plumbago, and carbon in various forms, mixed with tar and kneaded so that the same may be rolled out into wires of various lengths and diameters. Each wire, however, is to be uniform in size throughout.

If the carbon thread is liable to be distorted during carbonization it is to be coiled between a helix of copper wire. The ends of the carbon or filament are secured to the platina leading wires by plastic carbonizable material, and the whole placed in the carbonizing chamber. The copper, which has served to prevent distortion of the carbon thread, is afterward eaten away by nitric acid, and the spiral soaked in water, and then dried and placed on the glass holder, and a glass bulb blown over the whole, with a leading tube for exhaustion by a mercury pump. This tube, when a high vacuum has been reached, is hermetically sealed.

With substances which are not greatly distorted in carbonizing, they may be coated with a non-conducting non-carbonizable substance, which allows one coil or turn of the carbon to rest upon and be supported by the other.

In the drawings, Fig. 1 shows the lamp sectionally. *a* is the carbon spiral or thread. *c c'* are the thickened ends of the spiral, formed of the plastic compound of lamp-black and tar. *d d'* are the platina wires. *h h* are the clamps which serve to connect the platina wires cemented in the carbon, with the leading wires *x x*, sealed in the glass vacuum bulb. *e e* are copper wires, connected just outside the bulb to the wires *x x*. *m* is the tube (shown by dotted lines) leading to the vacuum pump, which, after exhaustion, is hermetically sealed and the surplus removed.

Fig. 2 represents the plastic material before being wound into a spiral.

Fig. 3 shows the spiral after carbonization, ready to have a bulb blown over it.

I claim as my invention:

1. An electric lamp for giving light by incandescence, consisting of a filament of carbon of high resistance, made as described, and secured to metallic wires, as set forth.

2. The combination of carbon filaments with a receiver made entirely of glass and conductors passing through the glass, and from which receiver the air is exhausted, for the purposes set forth.

3. A carbon filament or strip coiled and connected to electric conductors so that only a portion of the surface of such carbon conductors shall be exposed for radiating light, as set forth.

4. The method herein described of securing the platina contact-wires to the carbon filament and carbonizing of the whole in a closed chamber, substantially set forth.

The first and second claims are those upon which the contest is based. The first claim is held by Judge Wallace to be limited to the particular method of securing the filament to the conductors defined in the patent. As will be noted upon inspection of the patent, this method involves the union of the filament with the platinum leading-in wires, by moulding the filament when plastic around the wire and then carbonizing so as to form an intimate union. Judge Wallace decides that the defendant's lamp does not infringe this claim. But the second claim is sustained both as to validity and infringement, it being decided that every essential limitation to its validity can be consistently imported into its language from the specification.

It was contended for the defense, by the distinguished counsel who argued the case, that the first claim was invalid, for the reason that the word "filament" was not accurately definitive of a novel structure, inasmuch as the prior state of the art, involving incandescent lamps described in various patents and printed publications, showed the use of a carbon conductor enclosed in a vacuous glass tube, and that the words "high resistance" simply involved a question of degree and not one of invention; and against the second claim it was argued that it contained no invention in view of the radiometers, Geissler tubes and various patented lamps existing in the prior state of the art. This was met by proofs furnished by the prosecution that the result attained by the structure described in Mr. Edison's patent was one which had been long sought in full view of the low resistance carbon conductors known prior to Mr. Edison's invention, and that many able experimenters were disheartened over their failure to attain success. Judge Wallace very pointedly states the case as follows:

"It was a remarkable discovery that an attenuated thread of carbon would possess all the long-sought qualities of a practical burner when maintained in a perfect vacuum. The extreme fragility of such a structure was calculated to discourage experimentation with it, and it does not detract in the least from the originality of the conception that previous patents had suggested that thin plates or pencils or small bridges could be used. The futility of hoping to maintain a burner in vacuo with any permanency had discouraged prior inventors, and Mr. Edison is entitled to the credit of violating the mechanical difficulties which disheartened them, but what he did in this respect was a matter of only secondary merit and was no longer new in the art, because he had already disclosed it in his French and English patents.

"What he actually accomplished was to unite the characteristics of high resistance, small radiating surface and durability in a carbon conductor, by making it in a form for extreme tenuity, out of any such materials as are mentioned in the specification, carbonizing it, and arranging it as he had previously arranged his platinum burner in an exhausted bulb made wholly of glass, and sealed at all points, including those where the leading wires entered, by the fusion of the glass. He was the first to make a carbon of materials, and by a process, which was especially designed to impart high specific resistance to it—the first to make a carbon in the special form for the special purpose of imparting it to high total resistance, and the first to combine such a burner with the necessary adjuncts of lamp construction to prevent its disintegration, and give it sufficiently long life. By doing these things he made a lamp which was practically operative and successful, the embryo of the best lamps now in commercial use, and but for which the subdivision of the electric light by incandescence would still be nothing but the *ignis fatuus*, which it was proclaimed to be in 1879 by some of the learned experts who are now witnesses to belittle his achievement, and show that it did not rise to the dignity of an invention."

As abstracts of the several arguments made for and against the patent will be presented hereinafter, it will be unnecessary to further discuss the matter now. It will doubtless be interesting, however, to the readers of the REVIEW, to glance briefly at the main features of the state of the art as it existed prior to Mr. Edison's invention.

THE STATE OF THE ART.

Starr—1845.

The King British patent of 1845, issued upon an invention of an American named Starr, describes two forms of incandescent lamps, in which a metallic or a carbon burner may be used. When

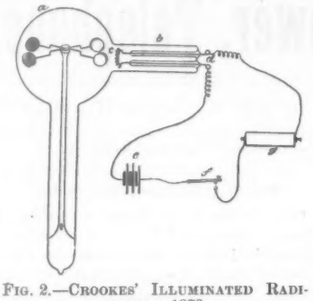


FIG. 2.—CROOKES' ILLUMINATED RADIOMETER, 1876.

carbon is used by reason of its affinity for oxygen it is enclosed in a Torricellian vacuum. A platinum wire is sealed into the top of the lamp bulb, and its inner end connects electrically with a carbon burner, the other end of which connects by means of a copper wire with mercury in a tube extending downward from the bulb, which acts as a seal for the vacuum.

Roberts—1852.

The British patent of Roberts of 1852 describes a pear-shaped glass globe, in which a carbon burner is arranged between two conducting wires entering a globe at its neck. The globe is partially of glass, the neck being closed with a metal cap through which the leading wires pass. The burner is described as a thin piece of graphite, coke or charcoal, or other infusible body, which becomes white hot under the current, and does not burn if the vacuum be perfect.

Dr. Adams' Efforts—1865 to 1867.

Figs. 3 and 4 illustrate several types of lamps designed by Dr. Adams in 1865 and 1867, the former being a reproduction of a page of Dr. Adams' note-book, and the latter a sketch made by him, illustrating lamps as he built them in 1865. They consisted of a carbon burner enclosed in a glass globe made like a Geissler tube, and from which the air was exhausted as completely as possible, by means of a Geissler mercury pump. The carbons were from an inch to an inch and a quarter in length, about three-sixteenths of an inch wide, and from five to ten thousandths of an inch in thickness. The carbons were supported in a horizontal position by being clamped upon the ends of short copper or brass wires which were brazed to short lengths of platinum wire, the latter being coated with glass and sealed into the glass globe of the lamp. The carbons were variously formed, sometimes of gas retort carbon, sometimes of plumbago, and sometimes from lead as taken from carpenter's pencils, which were ground down to the proper size. Other carbons were moulded according to the Bunsen process, by forming a mixture of lamp black and powered coke and molasses, baking, dipping in a sugar solution, and repeating the baking and dipping until a pure and tough carbon is obtained. These lamps were operated by 30 two-quart Bunsen cells, one being continued in action at a high state of incandescence for 200 hours. The half tone engraving, Fig. 3, is a reproduction of a sketch made in 1867, showing platinum conductors with hooks on the ends to support a carbon slip.

Geissler Tubes—1867.

In the accompanying engraving Fig. 1 illustrates a Geissler tube as arranged by Dumas and Benoit for lighting the galleries of mines exposed to fire damp. The apparatus is operated by the secondary of a Ruhmkorff induction coil, and comprises a lighting tube placed in a sort of cylindrical lantern, and enclosed in a protective casing to prevent breakage by shocks. The lamp shown at the right of Fig. 1 comprises a sort of eudiometric tube of crystal terminated by two caps of copper, which

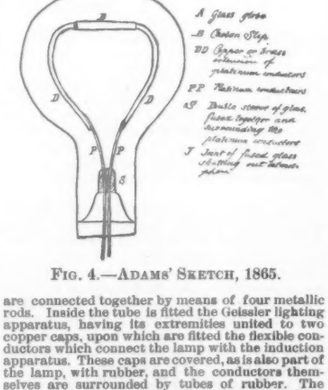


FIG. 4.—ADAMS' SKETCH, 1865.

are connected together by means of four metallic rods. Inside the tube is fitted the Geissler lighting apparatus, having its extremities united to two copper caps, upon which are fitted the flexible conductors which connect the lamp with the induction apparatus. These caps are covered, as is also part of the lamp, with rubber, and the conductors themselves are surrounded by tubes of rubber. The apparatus is suspended in the air by its conductors. Originally, in order to obtain a white light, a vacuum was made in the lighting tube (seen in coil-shape) by exhausting carbonic acid, but as this gas decomposed with continued use, simple gases, such as nitrogen, were preferred to be used, and in order to correct the red color, the coil tube was made of uranium glass. The light was said to be but little inferior to that of an ordinary safety lamp. The conductors by which the current was led to the vacuous or gaseous tube which furnished the light were of platinum, and sealed into the glass by fusion.

Crookes' Radiometers—1876.

The radiometer is a device composed of thin vanes of pith or mica silvered on one face and covered with lamp black on the opposite face and supported on a vertical axis in a high vacuum so as to be capable of rotation. On exposing the instrument to a candle or gas flame rapid rotation takes place. The lamp black surfaces absorb the radiant heat and becoming heated, the molecules of gas in the residual atmosphere will shoot violently from the heated surfaces and by their reaction drive the vanes around. Molecules are also shot off from the silvered surfaces, but as they are cooler the effect is not so great, and the differential action produces rotation. In order to show the difference of the action of one of these radiometers when exposed to luminous rays, and when exposed to heat rays, Professor Crookes made an apparatus, as illustrated in Fig. 2, containing a wire in the shape of a coil or loop rendered incandescent by an electric current; the leading conductors were sealed into glass stems throughout their length, the stems being connected to a projecting tube *b* of the radiometer, the whole being exhausted, and the wires connected with a battery and resistance coil *g*. The spiral *c* and the wires which were sealed in were of platinum, and were maintained at a red heat by the current.

The Woodward Patent—1876.

A United States patent, granted to Henry Woodward in 1876, describes a lamp which is illustrated in Fig. 5, comprising a glass globe A provided with brass sockets at the top and bottom, in which a piece of carbon B is supported by suitable conductors. The whole is exhausted and hermetically sealed at the ends, and then filled with a rarefied gas that will not unite chemically with the carbon when hot. The patent describes a system of distribution comprising two trunk wires leading from the positive and negative poles of the magneto-electric generator, and from which branches are taken in multiple arc to supply lamps.

Lane-Fox—1878.

The British patent of Lane-Fox, No. 4,626 of 1878, describes a long strip of wire in the form of a spiral, attached to platinum wires fused into a piece of glass, and then enclosed in a globular glass vessel, whose neck is sufficiently large to admit it; the neck being then closed up around the supporting wires, so as to make the vessel air-tight. A small tube projecting from the neck is then connected to a Sprengel air pump and the air completely exhausted, inert gas being then admitted and the tube hermetically sealed. The thickness of the spiral is stated to depend on the intensity of the light required, and the electromotive force available. Instead of the wire spiral, which becomes the source of light, carbon may be used, or a refractory compound of plumbago and magnesia, circonia, lime, steatite, or earthy matter, mixed in such proportions as to give the whole a specific resistance in accordance with the electromotive force employed for producing the light. The resistance of the luminous bridge, with an electromotive force of 100 volts, is described as being about 300 ohms. To produce a hard film of carbon on the surface of the incandescing conductor, it is heated to a high temperature by sending currents through it, while exposed to a dense hydro-carbon.

Pulvermacher—1878.

The Pulvermacher patent of November 3, 1878, describes the manufacture of a thin spiral carbon rod or thread from a compound of fine powdered pure charcoal, mixed with tar and pitch. This plastic material is forced through a draw-plate, and the thin rod thus produced is wound into a spiral around a larger central rod, and then the two are carbonized by being placed in a box filled with pulverized powder, and subjected to baking.

Van Choate—1878.

The Van Choate British patent of October 31, 1878, describes a burner composed of asbestos, mica, platinum, or carbon, or any combination of them, and a suitable binding agent. These materials are mixed to form a semi-metallic material, which becomes incandescent under the influence of electricity, but which does not volatilize, or melt, or fuse, under the influence of the current. This semi-metallic substance is made into wire or ribbon of proper size and formed into arcs spirally.

Sawyer & Man Patent of 1878.

The Sawyer & Man patent of June 18, 1878, an illustration of which is given in Fig. 5, described a glass tube A provided with a flange A' and a carefully ground stopper B, capable of making a hermetical seal when forced into tight engagement by bolts *j* and nuts *k*. The globe or tube is exhausted and filled with nitrogen, a small lump of sodium or potassium R and one of freshly burned lime S being placed inside to absorb oxygen and carbonic acid due to any trace of air. The conducting and supporting tubes J K are hollow for purposes of exhaustion and supply of nitrogen. A disk of soapstone C is designed to shut off heat from the lower parts of the lamp. A carbon rod E rests on a stout piece of carbon D, by the light pressure of rod F, sliding in ways in support H, so that in case of fracture of E, or partial consumption, F will decend and still maintain electric connection between E and D. The light is produced by the heating of rod E at E', between clamp G and carbon D.

Sawyer & Man Patent of December 10, 1878.

This is an improvement on the earlier device just described. It is illustrated in Fig. 5. Instead of the hollow tubes J and K, zigzag conductors are used, as being more pleasing to the eye. A spun metal cap G surrounds the tubes *b b* at the base of the lamp. After exhaustion of air and filling with nitrogen, the tubes are sealed with beeswax and the cap G is filled with melted beeswax and placed over the tubes, making a tight fit and hermetical seal with base plate D. A rubber stopper F insulates the leading-in conductor. The lamp is intended to be connected to a chandelier. Metal plates P P are used to cut off heat from the base of the lamp, instead of the soapstone of the other patent. The incandescing carbon O contacts at its ends with platinum or iridium tips in conductors K L, the latter being seated on a spring cushion to absorb vibration.

Farmer's Lamp—1879.

In Fig. 5 is shown a sectional view of a lamp patented by Moses G. Farmer in March, 1879. It comprises a glass bulb closed at the bottom by a soft rubber stopper D D', in which is fixed a non-conducting plug C containing the leading-in conductors, which are sealed in place by glue. Blocks of carbon F F' electroplated with copper at the lower ends, hold in position by spring pressure a thin piece of carbon H which becomes incandescent when current flows through it. The bulb is filled with nitrogen, two tubes I, closed by screw caps at the exterior ends, being used to introduce the gas which displaces the contained air.

Sawyer & Man Patent of 1885.

The lamp described in this patent is shown in section to the right of Fig. 5. The application upon which it was based was filed in January, 1880, and went through a sharply-contested interference in the Patent Office. The important feature of this patent was the arch of carbon A, which formed the incandescing conductor. The patent contemplated either a vacuum in the bulb, or an atmosphere of nitrogen, as in the former Sawyer & Man patents. The carbon is specified as formed from textile or fibrous material, the advantages of which were convenience of cutting and making the conductor of the desired form, the purity and equality of carbon obtained, susceptibility of tempering as to hardness and resistance, and toughness and durability. The arch shape permitted expansion and contraction. Suit was brought against the Edison Company under this patent, in Pittsburgh, but the case was dismissed by Judge Bradley, who held:

"We are not satisfied that Sawyer and Man ever made and reduced to practical operation any such invention as is set forth in the patent in suit. The evidence as to what they did up to 1879 is so contradictory and suspicious, we can with difficulty agree to the conclusion sought to be drawn from it. We are not satisfied that they ever produced an electric lamp with a burner of carbon made from fibrous material, or any material, which was a success. During 1878 and 1879, they obtained 19 electric lamp patents, and not one of them contains a hint of such an invention as that contained in the patent in suit, which was not applied for until 1880. The application for the patent in suit was not made until a year after their experiments ceased and after the inventions of Edison had been published to the world. Suppose they did construct a lamp with burners of fibrous material which continued to give light for days, or weeks or months—were they a successful invention? Would any one purchase them now? Did they not lack an essential ingredient, and did they go any further in principle, if they did in degree, than lamps constructed before? It seems to us that they were following a wrong principle. The great discovery in the art was that of adopting high resistance in the conductor, with a small illuminating surface and a corresponding diminution in the strength of the current. This was done by Edison with filamental conductors in a vacuum within a globe made of one piece of glass. This discovery made electric lighting practical in houses and cities. This discovery is traced in growth in both the Edison patents.

"What was the object of all the experiments made by Sawyer and Man and others? Was it not to make an electric lamp that could be successfully used by the public and have a commercial value? Did they succeed in making such a lamp, or in finding out the principle on which it could be made? We do not so read the evidence. The bill must be dismissed."

THE ARGUMENTS OF COUNSEL.

The case was conducted on behalf of the Edison Company by Grosvenor P. Lowrey, Clarence A. Seward, Sherburne B. Eaton and Richard N. Dyer; and on behalf of the United States Electric Lighting Company by Samuel A. Duncan, Edward Wetmore, Leonard E. Curtis and Frederick H. Betts.

Mr. Dyer for the Edison Company.

Mr. Dyer read the patent and defined subdivision to be the production of small lights as a substitute for gas jets at a commercial price. The important features of the Edison burner were its great resistance and slight radiating surface. The patentee made the important discovery that carbon in a high vacuum, even a carbonized filament of cotton thread, has stability. Mr. Dyer discussed the several constructions put upon the invention in the English cases and the German case. Referring to the suit on the Sawyer-Man patent, he traced the history of the Sawyer-Man application in the Patent Office and quoted Justice Bradley's favorable remark to Edison's efforts in the decision of that case. Both the radiating surface and high resistance of the filament were highly important factors. The important fact was that the quantity of heat developed in the conductor by the flow of current was independent of surface, but the temperature to which the conductor was raised by a given amount of heat was directly dependent upon the surface. The object of incandescent lighting was to obtain a small light as a substitute for a gas jet, and this necessitated a small radiating surface. (This was illustrated by placing three lamps in series, each of 40 ohms resistance, but having different radiating surfaces. When excited by the same current one showed a very bright light, one was only white hot, and the third barely visibly red.) Referring to the Scott lamp, as described in King's patent, he said it was admitted by all the experts that it was impracticable to make an operative carbon in the way described by King; that is, by mechanically reducing a rod of gas carbon. Again, it was a lamp of low resistance, from one to four ohms, and a series lamp, which could not be used in multiple arc. The Roberts British patent described a conductor of low resistance contained in a chamber of a character in which it would be impossible to maintain a vacuum. In these two lamps the question of radiating surface and high resistance played no part. Edison demonstrated the necessity of these considerations. He contended that the Geissler tubes and Crookes' radiometers had little bearing except that they show how to seal platinum into glass and how to form a high vacuum. The instability of carbon as used in all prior lamps, its volatilization destroying the rods and depositing carbon on the interior of the bells, showed that prior operators had been baffled in solving the problem of the subdivision of the electric light. Fontaine and other scientific writers, in full view of prior efforts, denied the possibility of divisibility of the electric light. Had Fontaine known how to make lamps of sufficiently stable to allow of economical subdivision of the electric light, and a possibility of competition with gas. This discovery of stability of carbon in a high vacuum made the modern incandescent lamp possible. (Drawings were exhibited showing the evolution of the Edison lamp from the discovery of the stability of carbon. Samples of conductors required to feed 100 sixteen candle lamps 100 feet from the generator, at 110 volts, were compared with a bunch of 400 similar wires, which were required to perform the same result with the old lamps having a carbon rod, thus showing that such a lamp in multiple arc distribution would be absolutely impossible on account of its cost.) Edison's experiments had demonstrated that the maintenance of incandescence in an atmosphere of nitrogen at atmospheric pressure, as used by Sawyer-Man, required nearly twice as much electricity as a burner in a high vacuum. Even after Edison's public exhibition of his lamp, Dr. Morton and others prophesied that it would be as great a failure as the other lamps had been. The skepticism of European electricians was not overcome until Edison exhibited his apparatus at the Paris Exhibition of 1881. In the Spring of 1880, the steamship "Columbia" was lighted with paper carbon lamps; later in the same year bamboo, which has ever since been used, was adopted as the basis for the carbon filament. The commercial success of the invention shows that it was one of great utility, and Edison merits for his patent the liberality of construction which the courts in the past have applied to patents of this character. He then paid his

(Continued on page 292.)

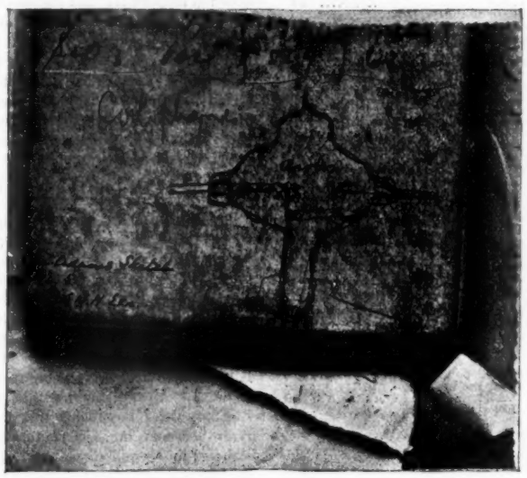


FIG. 3.—LEAF FROM ADAMS' SKETCH BOOK, 1867.

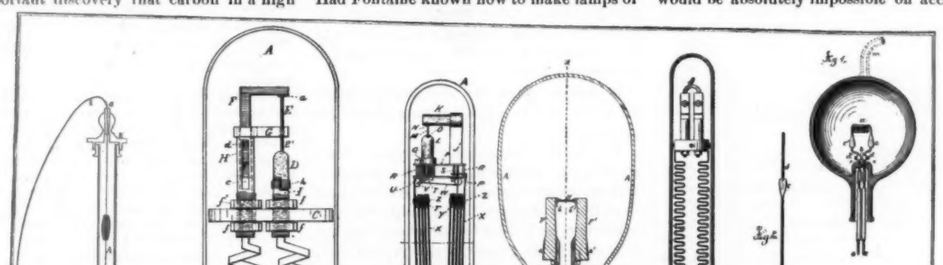

E. WOODWARD
Patented Aug. 29, 1876.
W. E. SAWYER & A. MAN
Patented June 18, 1878.
W. E. SAWYER & A. MAN
Patented Dec. 10, 1878.
M. G. FARMER
Patented Mar. 25, 1879.
W. E. SAWYER & A. MAN
Patented May 12, 1885.
T. A. EDISON No. 223,898
Patented Jan. 27, 1880.

FIG. 5.—INCANDESCENT ELECTRIC LAMPS PATENTED IN THE UNITED STATES.

Delhi, N. Y.—Delhi Electric Company; capital, $30,000.

Jersey City, N. J.—The Equitable Electric Company; capital, $250,000.

Portland, Me.—Eastern Electrical Supply Company; capital, $250,000.

Kennebunk, Me.—Kennebunk Electric Light Company; capital, $10,000.

San Francisco, Cal.—Edison Light and Power Company; capital, $3,000,000.

Upper Sandusky, O.—The Central Construction Company; capital, $200,000.

Bordentown, N. J.—The United States Heat, Light and Power Company; capital, $100,000.

Chicago, Ill.—The Morgan Park and Pullman Electric Street Railway Company; capital, $250,000.

New York, N. Y.—The Electric Magneto Ship Coating & Construction Company; capital, $2,500,000.

West Arlington, Md.—The West Arlington Telegraph, Telephone and Electric Light and Power Company; capital, $50,000.

Chicago, Ill.—The Illinois Electric Welding & Manufacturing Company; capital, $20,000; incorporators, Philip Harvey, John W. McElgh and R. L. North, Jr.

Portland, Me.—The New England Electric Brush Company, to manufacture electric brushes under the patents of Alexander Stanton; capital, $500,000.

Chicago, Ill.—National Gas and Water Company, at Chicago, to operate gas, water and electric works; capital, $500,000. Incorporators, C. D. Hank, E. E. Morrell and N. A. McClary.

Newark, N. J.—The Herzog General Electric Company; capital, $1,000,000. The directors are F. Benedict Herzog and Philip Herzog, of New York, and C. G. Frelinghuysen, of Newark.

Chicago, Ill.—The Armour Electric Light, Fuel and Power Company, of Illinois; capital, $5,000,000; incorporators, William L. Armour, Martin C. Burt, Allen T. Bennett and Clarence O. Scudder.

Camden, N. J.—Cutter Electrical Manufacturing Company; capital, $100,000. Incorporators, H. B. Cutter, Edmund Cobbe and Edward Dobelbower, of Philadelphia; Lucius F. Stanley, of Brooklyn, and William C. Jones, of Camden.

Chicago, Ill.—The Norwood Park and Maine Electric Railway Company, to operate a street railway from the village of Desplaines to some point in the city of Chicago; capital, $250,000; incorporators, F. J. Short, M. E. Cole, Russell O. Dunning and Andrew Dunning.

Los Angeles, Cal.—San Antonio Light and Power Company; capital, $240,000. The board of directors consists of Thomas R. Bard, Hueneme; N. W. Blanchard, Santa Paula; J. D. Hooker, Los Angeles; J. A. Dole, Pomona; M. B. Campbell, Claremont; A. W. Burt, Redlands; and C. G. Baldwin, Claremont.

Chicago, Ill.—The Inter-State Electric Railway Company, to build an elevated electric railway between Chicago and Milwaukee; capital, $10,000,000. Board of directors: G. I. Cox, Portage, Wis.; F. A. Deloglise, Antigo, Wis.; Ira C. Edwards, St. Paul, Minn.; J. W. Dickinson, Milwaukee; C. E. Cain, Milwaukee; Charles F. Goodrich, Chicago; Robert H. Clark, Milwaukee.

ELECTRICAL REVIEW

Published at 13 Park Row,
P. O. Box 3329. NEW YORK.

EDITOR:
CHARLES W. PRICE.
ASSOCIATE EDITORS:
STEPHEN L. COLES.
ROBERT H. READ.

REGISTERED CABLE ADDRESS:
"ELECTVIEW," NEW YORK.

"1546 CORTLANDT," TELEPHONE CALL.

BOSTON OFFICE:
W. I. BARKER, Room 29, 620 Atlantic Ave.
WASHINGTON OFFICE:
GEO. C. MAYNARD, 1409 New York Ave.
CHICAGO OFFICE:
L. W. COLLINS, 435 "The Rookery."
EUROPEAN OFFICE:
CHARLES FFRENCH, Editor for Europe.
HOTEL VICTORIA,
Northumberland Ave., Charing Cross, London, W. C.

Cable Address: - - "Electview," London.
Telegraphic Address: Ffrench, "Victoriola," London.

ADVERTISING DEPARTMENT,
H. T. RICHARDS, Manager.

PATENT BUREAU,
ROBT. H. READ, Manager.
Patents procured in United States and all foreign countries. Searches, Investigations and Reports on Validity and Infringement.

SUBSCRIPTION TO THE ELECTRICAL REVIEW.

One Year, United States and Canada, - $3.00
One Year, Foreign Countries, - - 5.00
Single Copy, - - - - .10

ANNOUNCEMENT.

Address all communications and make all money orders and checks payable to order of ELECTRICAL REVIEW, P. O. Box 3329, New York.

No attention will be paid to communications for the REVIEW without the *name and address of the writer.*

NEW YORK, JULY 25, 1891.

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To Dr. Otto A. Moses: Please bring on that incandescent lamp of yours.

For warm days, electrical affairs are quite active—probably a little too active for some.

To the electrician out of a job:, Make application at the Edison building, Broad street, for the position of royalty collector.

The REVIEW has spared no pains to present the lamp litigation in a comprehensive form. It is the only journal which has given a review of the entire situation. And it is done in a single issue.

Edison once remarked to the Editor of the REVIEW that he sometimes wondered if his competitors would ever admit that he had invented anything. Judge Wallace seems to have had a pretty clear idea that Edison had invented something.

It is announced that an elevated electric railway is to be built between Chicago and Milwaukee. The length of the line is estimated at 45 miles, and it will run through the counties of Milwaukee, Racine and Kenosha, in Wisconsin, and Cook county in Illinois. A company with $10,000,000 has been organized to promote the scheme. This is the biggest thing of the kind yet attempted, but if anybody can make it a success a body of Western progressives can.

Wall street men were waiting for the outcome of the great lamp suit, and when the decision was announced on July 14, the price of Edison stock immediately rose seven points. The buying was scattering, but brokers generally working for Standard Oil people were most prominent among the purchasers.

The Corporation Counsel has set Mayor Grant on his base again. The Czar-like resolution to forfeit the bond of the Subway Company, which "our active young Mayor" caused his dummy Board of Electrical Control to pass last month, has been declared inoperative and the board has been flatly informed that it had no authority to take any such action. It must be rather mortifying for the Mayor to have his monumental bluff exploded so completely, but if a man makes himself ridiculous over matters of such grave importance he can only expect to be brought up with a round turn when cooler heads and hands have the opportunity to check his wild outbursts.

This is, undoubtedly, after being the electrical, the tunneling age. The speed with which a tunnel can be built now, under favorable conditions, is most remarkable. The Vauxhall and Southwark Water Company, of London, has just built a tunnel about three-quarters of a mile long and nine feet in diameter, beneath the Thames at Kingston. There are two noteworthy points about this subway; the first that the roof of it is only three feet below the water in the river bed, and the second that it was constructed in 60 odd days. The system was the regular Greathead method of driving a circular shield through the clay and bolting together iron rings to make a continuous tunnel. By means of these light subways and electric motors many a rapid transit problem will be solved.

THE LAMP QUESTION COMMERCIALLY CONSIDERED.

The usual tedium of a Summer solstice has been enlivened by the decision in the Edison lamp suit. Interested people now have much to think and perspire about. The decision is all the more interesting just at this time, because it was rendered quite unexpectedly. After dragging through the courts for so many years it was hardly to be expected that a decision would be reached in such short order.

Looked at from the commercial standpoint the matter, to us, assumes about this shape:

The parties immediately interested don't seem badly frightened, as the Westinghouse reorganization was announced the very next day after the decision in the lamp suit. The injunction and order for an accounting applies only to the parties to the present suit, who will, we understand, appeal the case.

The Edison Company may choose either of two courses in dealing with the rest of the lamp manufacturers. Each one may be sued separately, or a compromise may be effected.

Provided Judge Wallace's decision is not reversed on the appeal, the Edison Company is practically possessed of a monopoly of the manufacture of incandescent lamps for the remaining five years of the life of the patent. Other manufacturers can pay tribute—or retire from business. The attitude of the Edison Company in respect to granting working franchises remains to be learned.

The practical results will, doubtless, be an improved quality of lamp, and possibly a cheaper one. Witness the Standard Oil Company, the greatest monopoly the world has ever seen. Petroleum has never been so good or so cheap as since the formation of this gigantic trust.

Theoretical argument is all against monopolies, but practical results often show that raw materials can be turned into finished products more cheaply when done on a large scale.

But the court of last resort is yet to be heard from, and until then much of the argument now in circulation is idle speculation.

THE INCANDESCENT LAMP RIDDLE ANSWERED.

Thomas A. Edison has been judicially declared the inventor of the incandescent lamp. For a period of five years ingenious lawyers have been wrestling to award or deny to him this palm. Judge Wallace's reasons for bestowing it are printed in full in this issue of the REVIEW. Aside from universal interest in knowing who is the donor of the magnificent gift of modern domestic illumination, weighty commercial interests are at stake, and it was no light task to reach a definite conclusion, especially in view of the enormous mass of testimony that was taken.

The REVIEW offers its readers a bird's-eye view of the whole situation from start to finish. As in the case of so many great triumphs of man's ingenuity, much was found in the prior state of the art to lend color to an opinion for or against, according to the interest or mental bias of the observer. In this age of push and bustle, the completion of an invention is like the end of a race—the winning horse leads but half a neck. It was so with the telephone. Ten years before Mr. Bell electrified the scientific world by sending a voice pulsating along a wire, Philipp Reis had made an instrument completely equipped to do the same work. It needed but the turn of a screw to have given birth to the telephone ten years before it was laid before the admiring world. The screw was there, but nobody turned it, and the marvelous potentialities it concealed slept until roused by Bell's magic touch.

The lamp case is equally striking. Rods and ribbons of carbon were mounted in vacuous chambers a decade prior to the birth of the Edison lamp. Judge Wallace holds that the general acknowledgment of failure of the early lamps invests with the highest importance the step taken by Mr. Edison when he made the filament which metamorphosed failure into success. Doubtless, Mr. Edison's moral right to the honor would never have been questioned, but that obscurities in the patent led to an uncertainty as to its commercial status. With an inventor so prolific, it would be astonishing if all of his patents, after traversing the labyrinthine ramifications of the Patent Office, were clear. In the mutations of his numerous patent applications relating to incandescent lighting, obscurities arose which clouded his title and invited commercial competition, and litigation offered the only solution.

The case was ably conducted on both sides, and in reading the successive arguments of the distinguished counsel, one is apt to sway to and fro in his judgment, like the bob of a pendulum, and come to rest where left by the latest pleader, so that the question is resolved into one purely of judicial construction, and will only receive a final answer when the last nail shall have been driven by the court of highest resort.

On July 11 the postmaster at Cincinnati, Ohio, had a postal card with the address "The Leading Paper on Electricity, Cincinnati, Ohio," referred to him. The second page carried this:

Brazil, Ind., July 10, 1891.

Gentlemen: What is your subscription and size of paper? Please send me a copy.

Yours, etc., BERT DECKER.

As there is no paper on electricity published in Cincinnati, the postmaster immediately forwarded the postal to "the leading paper on electricity," the ELECTRICAL REVIEW, 13 Park Row, New York.

A press dispatch from Hartford tells us that one of the matters which may engage the attention of the present Connecticut Legislature is the question of the substitution of electricity for hanging in the infliction of the death penalty. The report of the recent electrical executions at Sing Sing has aroused interest in the subject there. The Hon. F. S. Stevens, one of the representatives of Bridgeport, will probably introduce the bill. He would be very careful, however, to expunge the clause regarding secrecy, which he regards as un-American and unconstitutional, besides. Our advice to Mr. Stevens is to make haste slowly in this matter unless he wants to drop into bitter and unadorned political oblivion with the author of Gerrycide.

CORRESPONDENCE.

OUR BOSTON LETTER.

The Clemons Electrical Company, Attleboro, Mass., makes a number of meritorious electrical novelties which are meeting with large sales.

The New England Lunch Club, in the New England Building, No. 180 Summer street, this city, is the favorite resort for hungry electricians.

Mr. Fred. S. Palmer, general manager of the Ellsworth Electric Illuminating Company, of Ellsworth, Me., favored this office with a visit early in the week.

Mr. H. C. Hawks, a well known electrical engineer, of this city, has just completed the installation of an isolated electric light plant at the new hotel at Magnolia, Mass. The equipment includes a 600 light Edison dynamo.

Mr. D. W. Dunn, who was for a number of years connected with the Thomson-Houston Electric Company's Boston office, and is at present looking after the same company's interests in Western Pennsylvania, was in the city to-day.

Mr. Willis L. Adams, traveling representative of the Electric Merchandise Company, of Chicago, states that he does not contemplate locating in this city as mentioned in my Boston letter of July 4. Mr. Adams resides at Buffalo, N. Y.

The Berlin Iron Bridge Company, of East Berlin, Conn., the widely known and successful builders of numerous fire-proof electric light stations, has been awarded the contract for erecting several steel buildings at Great Falls, Montana, for the Boston and Montana Mining Company.

Electric Cars for Marblehead —The selectmen of Marblehead, Mass., held a meeting July 15, and granted permission to the Naumkeag Street Railway to erect poles and string wires along the entire line of the latter in town named. Single trolley system will be used and it is expected that the electric cars will be running by August 15.

The Holtzer-Cabot Electric Company, of this city, is now comfortably settled in its new and extensive offices at No. 92 Franklin street, near Devonshire. Adjoining the offices are the sample rooms and sales department, covering three times more floor space than those previously occupied by the company. This will greatly facilitate the prompt handling of this company's steadily increasing business.

Proposed Electric Mail Service. — It is rumored hereabout that the United States government contemplates establishing at an early day a pneumatic or an electric mail service within the limits of the Boston postal district. Such a service if adopted will not only be self-sustaining, but it will prove an invaluable adjunct to the postal system of this city. The quickest and best mail facilities are a necessity, and the proposed improvement as rumored will be appreciated by business men of this city. W. I. B.

Boston, July 19.

OUR CHICAGO LETTER.

Mr. Geo. F. Card, of the Fort Wayne Electric Company, spent a day or two in the city this week.

Mr. James Charter, son of the inventor of the well-known Charter gas engine, spent a few days in Chicago this week.

Otto V. Bacheile, a rising young electrician, has established himself at 18 Gilpin Place, this city, and is prepared to build small dynamos, switches, in fact, complete outfits for small plants.

The Electric Merchandise Company has just secured the contract for the overhead fixtures for six miles of electric road at Mansfield, Ohio, from the Citizens' Electric Railway, Light and Power Company.

The Great Western Electric Supply Company have secured two floors of the Springer building, 75x175, for manufacturing purposes. Their salesrooms and general offices will still remain in the central part of the city.

The Right of Way has been secured for a new street railway in this city, starting from a central point and running in a northwesterly direction through the city for about nine miles. It is probable that storage batteries will be used.

Mr. Fred Merrill has given up the agency of the Eureka Electric Company (Loomis system) and will hereafter handle the apparatus of the Jenney Electric Motor Company, of Indianapolis. He is securing a satisfactory motor business for the Jenny people, having had this agency for some months.

Mr. D. B. Dean, of the Electric Merchandise Company, is having a very successful trip through the large cities on the Pacific coast. While in Vancouver, B. C., Mr. Dean took an order for over five miles of overhead material and wire, and has sold on this trip 150 of the Electrical Merchandise Company's rawhide pinions.

The Plant of the New Albany Light, Heat and Power Company was sold at auction Thursday, July 16, for $40,000, to Messrs. Ruthenburg, Basth, Huffman & Briggs. The plant was bid in at the above figure. The order of the court was that no bid for less than $40,000 would be entertained for the plant free from all claims and indebtedness.

Mr. F. H. Soden, well known in electrical circles and formerly connected with the Chicago offices of the Thomson-Houston Company and Edison Company, five years with each, has formed a copartnership with Mr. G. H. Bliss, and will carry on a general electrical engineering and construction business. The name of the new firm will be Bliss & Soden, located at 225 Temple Court, Chicago.

The New York Safety Steam Power Company, through their Chicago agent, Mr. Milton Thomas, report recent sales as follows: Entire steam plant for the electric light plant at Wheaton, Ill.; a steam engine to the Rector Oyster House, Chicago; two 60 horse-power engines to the new Manhattan 17 story office building. This building has been wired throughout by the Electrical Engineering Company, 320 Dearborn street, and two 500 light incandescent Fort Wayne dynamos will be installed.

The Electrical Engineering Company have secured the agency of the Interior Conduit and Insulation Company for the States of Illinois and Indiana. This company have also secured the wiring of the 500 light extension at the Underwood Packing Company's packing house. The well known Clark wire, for which this company is agent, will be used throughout. Mr. R. E. Richardson, of the Electrical Engineering Company, is at present out of the city on a Southern business trip. L. W. C.

Chicago, Ill., July 19.

OUR CINCINNATI LETTER.

Mr. Cochrane, of the Revere Hard Rubber Company, is in the city for a few days.

Mr. E. I. Robinson, of the Cincinnati Railway Company, has accepted the position of vice-president and general manager of the Laclede Car Works, of St. Louis.

Mr. J. H. Rhotehamel, president of the Columbia Incandescent Lamp Company, of St. Louis, was in the city for a few days, and reports a large increase in the sale of his company's lamp.

The Mount Adams & Eden Park Railway was started on the 4th of July. This division of the Cincinnati Street Railway Company runs to Norwood, and the patrons had a big jubilee on the opening day, over 10,000 people being carried.

The Edison General Electric Company have just completed six cars for the Cincinnati Incline Plane Railway, all equipped with two 15 horse-power Edison motors. They also are installing two generators in the power house of this railway. E. S. M.

Cincinnati, July 16.

OUR ALBANY LETTER.

An Electric Railroad is to be built between Ballston and Rock City Falls, Saratoga county, N. Y. It is designed to carry both freight and passengers, and will be ready for business about October 1.

The Deed of Receiver J. J. Cassin, of Troy, has been filed in the county clerk's office at that city, transferring to Anthony N. Brady, of Albany, the Troy Electric Light Company's plant for $90,000.

The Recent Meeting at Sandy Hill, N. Y., for the purpose of organizing an electric light company was well attended. The project was favorably considered, and about $5,000 worth of stock taken at once.

B. B. Odell, Jr., of Newburgh, N. Y., has the contract for lighting Haverstraw with electricity, and the plant is nearly ready for business. The machinery is fast nearing completion, and it is expected that lighting will be begun next Thursday.

The Electric Light System for Watkins, N. Y., is on the rush. Wires are going up rapidly. Part of the engine and dynamo have arrived, and the remainder of the machinery is on its way. Thus far about 800 incandescent lights have been put up in stores and private dwellings. A great many more are expected.

Motor Car No. 181, of the Troy and Lansinburgh Railroad, Troy, N. Y., was nearly destroyed by fire Thursday afternoon, June 9. The car was between Seventh and Eighth streets, in Lansinburgh, when the flames burst through the floor and caused the few passengers to make a speedy exit. The car was stopped, and with difficulty the flames, which soon reached the sides, ends and roof, were extinguished. It is a remarkable fact that nearly all similar fires in motor cars which have occurred on this road have happened between the two streets where No. 181 burned. This is regarded by motor car conductors as the most dangerous point on the line. L. M. W.

Albany, July 18.

The Mystery of Lightning Shocks.

A correspondent writes to the New York *Sun* as follows:

I think that all of the primarily fatal effects of electricity are due to one of three causes which are distinct but inseparable, and each capable of producing death if sufficiently powerful.

The most prominent of these is the forcible contraction of the muscles, which may be drawn so tightly about the arteries as to produce congestion and stop the action of the heart.

The caloric effect of electricity is to increase the temperature of the parts through which it passes, and this may produce their disruption or combustion. The current also exerts an electrolytic action on the fluid and nervous portions of the system.

The magnitude of these effects is proportional to the electromotive force of the current; practically proportional to the duration of its flow and inversely proportional to the resistance of its path or circuit.

If the conjoint influence of these effects "paralyzes the nerves," or produces unconsciousness otherwise, in less than three one-hundredths of one second, it must act more quickly than sensation and produce a painless death; but, if this period be prolonged, the subject will die a most agonizing death. He will feel that his muscles are being stripped from the bones, that each nerve is a conductor heated to intensity by the current that sears, burns, fries the parts adjacent which offer a greater resistance to its flow; that he is being burned to death by fires internal, or that a demon has an iron grip on every inch of him and is rending piece from piece in the fires of hell. My own experience justifies this conclusion. The duration of consciousness under these circumstances is dependent, other things equal, upon the electrical resistance of the individual and his powers of endurance; perhaps it may last five minutes in extreme cases. In other exceptional instances death may be sudden—almost painless. A more uncertain or a more likely inhuman method of taking life has not yet been devised.

The law of electrical execution was conceived and ratified by persons ignorant of electric science, who probably recall the fact that men and animals have been instantly killed by lightning, and drew this unfounded conclusion that artificial electricity would be equally effective.

The electromotive force of an ordinary flash of lightning can be only estimated in billions of volts. The comparative power of artificial and atmospheric electricities may be inferred from the following comparison: The spark given by the electric current is proportional to the square of its electromotive force, and that of the most powerful dynamos does not exceed the thirty-second part of one inch; but that of a flash of lightning "varies from one to two miles in ordinary flashes to eight or ten miles in exceptional cases." (See Humboldt Library, 139.) The same authority informs us that only one case in three is fatal of those struck by lightning.

There has not yet been an artificial current produced of sufficient power to destroy life instantaneously with certainty.

An interesting and practical article relating to newspaper advertising appears in this issue of the REVIEW from the able pen of Mr. C. M. Wilkins, a member of the Partrick & Carter Company, of Philadelphia. Every advertiser should read it.

"Selections from Papers Presented During the First Fiscal Year, November 21, 1889, to November 13, 1890," before the Engineering Association of the South, forms Publication No. 1 of that new and flourishing organization. A list of officers and members accompanies this pamphlet.

The Brown & Sharpe Manufacturing Company, Providence, R. I., has issued a handsome pamphlet, with illustrations, on the "Construction and Use of Universal and Plain Grinding Machines For Cylindrical and Conical Surfaces," as manufactured by this company. The subject matter is practical, direct and margin references make it easy of access. The design of the treatise is to assist the novice in becoming familiar with the construction and use of grinding machines. A complete description of each machine is given, although they have many features in common. To the descriptions have been added many suggestions in regard to the care and use of the machines, and a number of examples showing their adaptations to different kinds of work. There are also included a few pages on the measuring tools advantageously used by those operating grinding machines.

The Incandescent Lamp Decision.

HOW MR. EDISON RECEIVED THE NEWS—"GOOD, BUT WHY DID YOU WAKE ME UP?"

A short time before the decision in the lamp suit was expected, Mr. Edison isolated himself by retiring to his iron mines at Ogden, N. J. Mr. W. S. Perry, of the Edison General Electric Company, has been with him there during the past week.

When the decision was announced on the 14th, a special courier was dispatched to find Mr. Edison to let him know of the great victory he had won. A large number of telegrams were also sent to various points, in the hope that one might reach him. All this was made necessary because none of those nearest to Mr. Edison knew exactly where he had gone.

Mr. Perry returned from Ogden Sunday evening, and in an interview with one of the Editors of the REVIEW related the story of how Mr. Edison received the news. Mr. Edison's actions were characteristic of the man.

Mr. Perry said: "Mr. Edison had been working the night of the 13th, and had gone to sleep early in the morning of the 14th, on a cot in the upper part of the office building at the Ogden iron mines. He left orders to be wakened at one P. M.

"About noon I received four dispatches announcing Judge Wallace's decision. The news was proclaimed to those in the office. One of the men in the office said he would take the dispatches up to Mr. Edison. 'But he didn't want to be called till one o'clock,' said I. 'I know,' replied the man, 'but the matter is so important that I think he ought to hear about it at once.' 'All right,' I said, handing him the telegrams, 'go ahead, but don't say that Mr. Perry sent you.'

"Up went the man with the telegrams. He says he woke Mr. Edison and handed the dispatches to him. 'Good,' said Mr. Edison, 'but what the dickens did you wake me for?' With that he turned over and went to sleep again.

"In about an hour Mr. Edison came down into the office and gave me a raking over for letting the man call him. 'If you hadn't shown that fellow the telegrams, he wouldn't have disturbed me,' said he. 'How do you feel about it?' I asked, 'are you surprised at the decision?' 'Yes and no,' he replied, 'I was afraid that the financial interests at stake on the other side were too large. But if I didn't invent that lamp, I'd like to know who did!'"

Incandescent Lamp Association—Opinions on the Edison Case.

An association of incandescent lamp manufacturers was formed at the Astor House, New York, June 17. The meeting was secret, but it is learned that the objects were to form a combination of the smaller manufacturers to protect themselves in the matter of prices and output. There were no Edison or Sawyer-Man representatives at this meeting.

After Judge Wallace's decision, on July 14, a meeting of this Association was called for July 17, to discuss the situation. For some good reason, presumably, this meeting was indefinitely postponed.

It was learned that the president of this Association is Mr. Cook, of Chicago; the secretary is Mr. O. K. Stuart, of the Germania Electric Company.

Opinions on the decision were hard to get from those who will be most affected by it.

Mr. P. H. Alexander, of Alexander, Barney & Chapin, said: "The decision is very broad. I am not prepared to say how it will affect the A. B. C. lamp."

Mr. Henry B. Cram, general manager of the Bernstein Electric Company, Boston, said: "I think any expression of opinion on my part would be premature. I have lost no sleep over this decision, and I never cross a bridge till I come to it."

Mr. John W. Peale, president of the New York & Ohio Company, makers of the Packard lamp, had nothing to say.

Mr. W. Dwight Wiman, general manager of the Richmond Light, Heat & Power Company, of St. George, S. I., said: "This decision is a good thing. It will freeze out the little fellows and we will get a better incandescent lamp than we have had heretofore. The lamp industry will be greatly benefited."

We present in this issue several examples of the latest incandescent electric lamps.

Telephonic News

*** The Philadelphia *Telegraph* receives its New York news by direct telephone.

*** The telephone girl may be frivolous, but everything she says goes.—*Exchange.*

*** The exchange of the Bell Telephone Company at Ottawa, Canada, was destroyed by fire July 11.

*** The Rocky Mountain Bell Telephone Company has amended its articles of incorporation. By the change the capital stock is made $500,000.

A Big Purchase by the American Bell.

The American Bell Telephone Company has absorbed the Federal Telephone Company, of Montreal, thus securing control of the telephonic business of British North America.

Massachusetts Electric Association.

The Association held its annual banquet at Hotel Pemberton, Hull, Mass., July 8. The following officers for the ensuing year were elected: President, F. A. Gilbert, Boston; first vice-president, Hon. Theodore C. Bates, of Worcester; second vice-president, Hon. George W. Fifield, of Lowell; secretary, E. W. Burdett, of Boston; assistant secretary, B. W. Cutter, of Boston; treasurer, Samuel S. Sias, of Boston. Executive committee, C. L. Edgar, Boston; H. F. Coggeshall, Fitchburg; Elisha Morgan, Springfield, and James F. Almy, Salem.

The secretary's report shows that the Association now has upon its rolls representatives of 36 Massachusetts companies, representing eight-tenths of all the capital invested in electric lighting in the State. All these companies were represented at the meeting.

Inspecting Electric Light Plants.

St. Louis was honored with two distinguished parties of visitors recently. One consisted of the Electric Light Commission of Wheeling, W. Va., numbering 15. The other party consisted of the same number of gentlemen from Marion, Ind. Each party was made up of official representatives of their respective municipalities, on a tour of inspection to learn what was the best kind of an electric plant to use in the illumination of a city, both cities designing to put in plants of that kind. The Wheeling delegation consisted of Messrs. P. F. Farrell, A. A. Franzheim, J. A. Campbell, Albert Capper, C. W. Kreiter, Charles Craig, of the City Council; H. H. Dunlevy, A. J. Schultze, W. H. Shafer, of the city's Board of Light Commissioners; S. M. Dansch, superintendent of the gas works; John A. Seeley, of New York, the well known electrical engineer; J. W. Phœbus, of the Wheeling *Intelligencer*; W. C. Beans, of the Wheeling *Register*, and S. C. Knight, of the Chicago Electric Company.

Wheeling at present has its streets illuminated by gas only. The gas works are owned and operated by the city at a cost to consumers of 75 cents per 1,000 feet only, a reduction, since the city began running the works, of $2.25 per 1,000 feet. Not content with this cheap illumination, the city seeks more light, the Council having appropriated $100,000 for the construction of an electric plant. The gentlemen mentioned are on a tour of inspection to see where the best plant is in use, and to imitate it in the construction of the one used at Wheeling. Thus far the tourists have visited Pittsburgh, Cleveland, Toledo, Chicago, Buffalo and Fort Wayne. They arrived in St. Louis, July 12, and, under the guidance of James I. Ayer, manager of the Municipal Electric Light and Power Company, were conducted about the city to see the electric lighting stations. They will, before returning home, visit Detroit, Albany, Boston, New York and Philadelphia.

The Marion party consisted of George H. Moore, James Charles, Charles Zimmerman and 12 others, and this party joined the Wheeling officials in their investigating tour. Manager James I. Ayer took the two parties to Uhrig's Cave to enjoy the opera.

The Edison Company Buys the California Electric Light Company.

At San Francisco, July 1, the Edison Light & Power Company was incorporated with $3,000,000 capital. July 2, this new company acquired by purchase the entire plant, franchises and all other property of the California Electric Light Company. The consideration was $1,000,000 paid in stock of the Edison Light & Power Company.

The new company will immediately build another central station and equip it with $500,000 worth of Edison apparatus. The new Edison direct-connected triple-expansion engine and generator will here be used for the first time in any central station. Each generator will have a capacity of 8,000 lights.

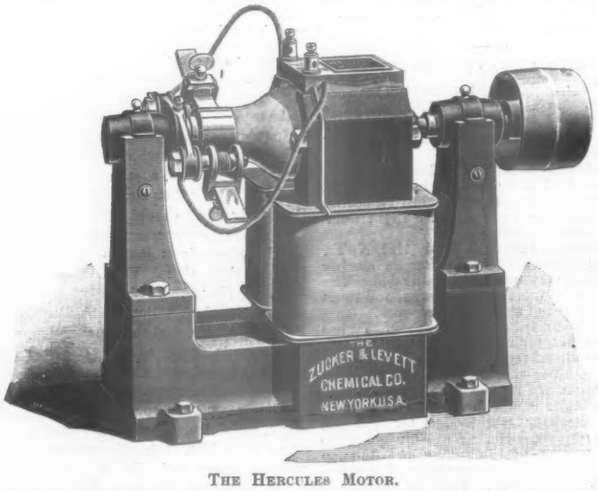
The California Electric Light Company owns valuable rights for the sale of Brush apparatus in the Pacific States, and it will hereafter devote its attention to the business of selling apparatus both for electric lighting and electric railways.

This new deal is valuable to both parties. It gives the California company, under another name, new capital and enlarged facilities for carrying on the lighting business, while to the Edison Company will accrue the profitable business of one of the staunchest companies in the country, and one, too, that has no competitors.

The Hercules Electric Motors and Dynamos.

On this page we illustrate a new motor which has been placed upon the market by the Zucker & Levett Chemical Company, of this city. The motor is of the inverted horse-shoe type, in which the whole of the magnetic circuit is stamped out of one sheet of best Swedish iron, a number of sheets being bolted together to form the magnet frame. The plates are thoroughly insulated to prevent the generation of Foucault currents and consequent heating. The field coils are separately wound on brass spools and the distance between the magnet cores is slightly larger than twice the depth of one coil, thus allowing the same to be slipped over the core.

The plates of the armature, which is of the modified "Siemens" type, have teeth forming longitudinal channels on its periphery in which the coils are wound. These teeth, besides reducing the magnetic resistance to a minimum, entirely prevent the coils from flying out due to the centrifugal force and consequent burning out of the armature.



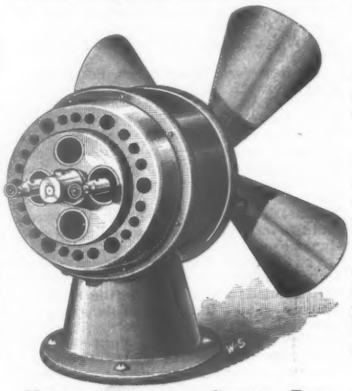
THE HERCULES MOTOR.

The magnet frame is bolted to an iron base, having iron standards and self-oiling bearings, even in the smallest sized machines. There is no sparking of the commutator. The automatic motors are shunt wound with an armature of extremely low resistance. The fan motors are series wound and run a six blade 12 inch fan at 1,600 revolutions per minute, taking one ampere at 120 volts.

Niles, Ohio, will sell $50,000 worth of bonds to put in water works and an electric light plant.

The Meston Alternating Current Fan Motor.

The illustration presented herewith shows the Meston alternating current fan motor, manufactured by the Emerson Electric Manufacturing Company, St. Louis. The motor was designed by the electrician of the company named. It is of one eighth horse-power and takes 1.8 amperes on a 52 volt circuit. The motor is very simple in its construction, and all the working parts and coils are enclosed and out of the reach of injury. The magnetic portions of the motor are made of very thin sheets of the best charcoal iron, and the shaft is of high grade Stub's steel. The bearings are self-oiling and all parts are made true to gauge and interchangeable.



MESTON ALTERNATING CURRENT FAN MOTOR.

The fan is 11 inches in diameter, with four blades three and three-fourth inches wide, having a pitch of one and one-half inches. The fan revolves 2,500 times per minute and furnishes a powerful breeze. Owing to its good construction and low price, this motor is meeting with a very large sale.

Westinghouse Company Reorganized.

At a meeting of the stockholders of the Westinghouse Electric Company, held at Pittsburgh, July 15, it was unanimously decided to accept the plan of reorganization recently proposed. The following board of directors were elected: Charles Francis Adams, Boston; Lemuel Bannister, Pittsburgh; August Belmont, New York; A. M. Byers, Pittsburgh; Charles Fairchild, Boston; Marcellus Hartley, New York; George W. Hebard, New York; Henry B. Hyde, New York; Brayton Ives, New York; George Westinghouse, Jr., Pittsburgh. The present officers hold over until a meeting of the board is held.

By the plan of reorganization, $4,000,000 of seven per cent. cumulative preferred stock is created, of which $3,000,000 has been taken at par by the reorganization syndicate to care for the company's floating debt and provide additional capital. The assenting stockholders give up 40 per cent. of their stock, aggregating over $2,500,000 par value, for the use of the company, and receive upon the 60 per cent. of stock which they retain a seven per cent. preference over the small amount of non-assenting stock remaining out.

ELECTRIC LIGHT NOTES.

—— The Waterville, Me., city government has contracted with the Edison Company for an electric light plant to cost $20,000.

—— Craig & Sons, electricians, of Montreal, have made an assignment. The liabilities are about $72,000. The creditors are local people.

—— The National Electric Manufacturing Company, of Eau Claire, has presented a dynamo, having a capacity of 30 incandescent lamps, to the Wisconsin State University.

—— It is reported that the Chicago Edison Company will sell its lease of the building at Nos. 139 and 141 Adams street, and erect a large building in some other portion of the city.

—— It cost Peabody $520.40 to contend with the electric lighting companies before the legislative committee. The total expense to date is $1,500 in the matter of a town plant.—*Peabody, Mass., Reporter.*

—— The Edison General Electric Company is adding four new buildings to its plant in Schenectady, N. Y. When completed, the plant will consist of 21 brick and 35 frame buildings. About 3,500 men are paid every Saturday.

—— At 11.55 P. M., July 14, an immense gas tank belonging to the Municipal Gas Company, of Rochester, N. Y., exploded. The company will sustain a loss of about $60,000. Two men were killed, several injured and all the glass in the vicinity was shattered.

—— The second suit of the Pittsburgh Reduction Company against the Cowles Electric Smelting and Aluminum Company, of Cleveland, to restrain them from selling aluminum below the market price, was decided in favor of the latter company by Judge Ricks, of the United States Circuit Court, at Cleveland.

—— A three years' contract has been made by the commissioners of the District of Columbia with the United States Electric Lighting Company, for city lighting, at the rate of 50 cents a night for each lamp. A contract has also been made with the Washington Gas Light Company for the same period for lighting, extinguishing and cleaning gas lamps, at the rate of $21.50 per year for each lamp. All lamps, both electric and gas, are to burn 3,000 hours a year.

—— Judgment for $35,466 was entered July 9, against the Manhattan Electric Light Company and the Harlem Lighting Company, of New York, in favor of the Thomson-Houston Electric Company on seven promissory notes of $5,000 each, made on October 22, 1890, by the Harlem Company and indorsed by the Manhattan Company. Both these companies were closely connected in business and are located at Eightieth street and Avenue B. The defence claimed that the notes were accommodation notes, made and delivered to the Thomson-Houston Company for the sole purpose of its using them in payment of its contribution to a certain syndicate, and that it did not so use the notes, but caused them to be presented for payment. On June 12 last the Manhattan Company obtained a judgment for $142,802 against the Harlem Company. The latter company has a capital stock of $250,000, and the Manhattan $2,000,000. The defendants have taken proceedings to set aside the judgment.

Doff Your Hat, Mr. Tesla.

Now that Edison's right to the incandescent lamp is established by a decision of the courts, it would be interesting if a new wizard came along and demonstrated that a glass-inclosed vacuum, placed within the region of influence of widely separated electrodes, would give out as much light as an incandescent filament. That is the lamp of the firefly, and unless one experimenter is mistaken, he has almost mastered the secret. —*New York Morning Advertiser.*

ELECTRIC POWER NOTES.

* * The Thomson Electric Welding Company commenced business with six patents. It now has 130.

* * Rails are being laid for the interstate electric road between Attleboro, Mass., and Pawtucket, R. I.

* * It is proposed to construct an electric railway from the Hudson River, at Yonkers, N. Y., to the Sound at New Rochelle, N. Y.

* * The American Projectile Company, of Lynn, Mass., expects to commence manufacturing electrically welded shells, under its contract with the government, in about two weeks.

* * Verbatim Report of the Ninth Annual Meeting of the American Street Railway Association," held at the Hotel Iroquois, Buffalo, N. Y., October 15 and 16, 1890, has been received.

* * Headquarters for the Boston Rapid Transit Commission have been established at No. 53 State street, Exchange building, Rooms 306 and 307, where the chief engineer and clerk will be found daily between 9 A. M. and 5 P. M.

* * The Allentown, Pa., *Item* observes that the running of the electric cars has accelerated the pace of everything and that "people walk faster, make money faster, marry faster and live faster," under the influence of the subtle electric fluid.

* * The electric tramcar system has been so successful since the Frankfort Exhibition opened, that the directors of the Frankfort Forest Railway have ordered an accommodation car from Nuremburg to test the possibilities of its superseding the steam engine.

* * An application was made to the Jamaica, L. I., Town Board, July 14, by the Brooklyn City Railroad Company, for permission to extend its Myrtle avenue line to Richmond Hill. Many property owners along the proposed extension were present at the meeting. They all favored the proposed extension. President Lewis, of the railroad company, said that the company intended to operate the whole road eventually by electricity. The next hearing will be on September 14.

* * Negotiations are under way for the building of an electric railroad from Newark to Jersey City, N. J., along the line of the plank road. The parties to these negotiations are the Jersey City and Bergen Railroad Company, of Jersey City, and the Newark Passenger Company and the Rapid Transit Street Railway Company, of Newark. The Pennsylvania Railroad Company is largely interested in the Jersey City and Bergen Railroad Company, and is said to be backing the new enterprise. It is stated that a capital of $25,000,000 will be required to perfect the road in its details.

National Electric Light Association.

The Citizens' Committee, of Montreal, are pushing forward to completion their plans for the entertainment of the National Electric Light Association with the vigor for which the good people of that city are so noted. The corporation of the city has just voted the appropriation of a large sum of money to be placed at the disposal of the Citizens' Committee. The use of quite a number of yachts has been tendered by private gentlemen of Montreal, especially for the pleasure of the ladies attending.

President C. R. Huntley, of the Association, informs us that a new feature will be introduced this year, as suggested by the executive committee, which will add to the interest and the diffusion of practical information on the details of work in connection with the operating of central station and other plants. A "Question Box" will be placed at headquarters in Montreal for the reception of written questions upon any pertinent subject. This box will be opened prior to each session, the questions read in open convention, and answers requested from those who are willing to speak upon the subject. This plan will, no doubt, be very favorably received, and will give excellent practical results.

Edison Electric Pump.

The accompanying illustration shows one of the latest productions of the Edison General Electric Company. It is a combination of a 25 horse-power electric motor and a Blake double-acting pump, both placed on one bed-plate. This electric pump is designed especially for use in mining work.

The motor is series wound and designed to operate at 800 volts; it can be supplied, however, wound for any of the standard voltages. The field coils are divided into three sections, and the regulation of speed is effected by commutation of these sections by means of an ordinary car-controlling switch. The armature shaft is connected by a worm driving a large gear wheel to a pair of crank disks, one on each side of the machine. Wrist pins, placed at an angle of 90° with each other, carry the connecting rods operating the plungers of the double cylinder pump, which is mounted on the same bed-plate with the motor. Each pair of plungers being connected together by outside rods work together like one plunger, and the connection with the crank disks being at an angle, one pair of plungers is drawing while the other is forcing water, thus making them double-acting. The size of each cylinder is five inches diameter by 12 inches length.

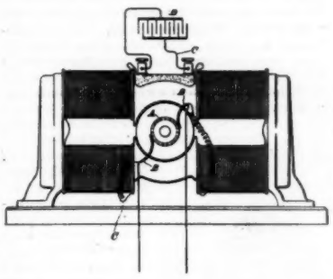
A series of tests recently made shows this pump to be of a high order of efficiency.

A Successful Bank.

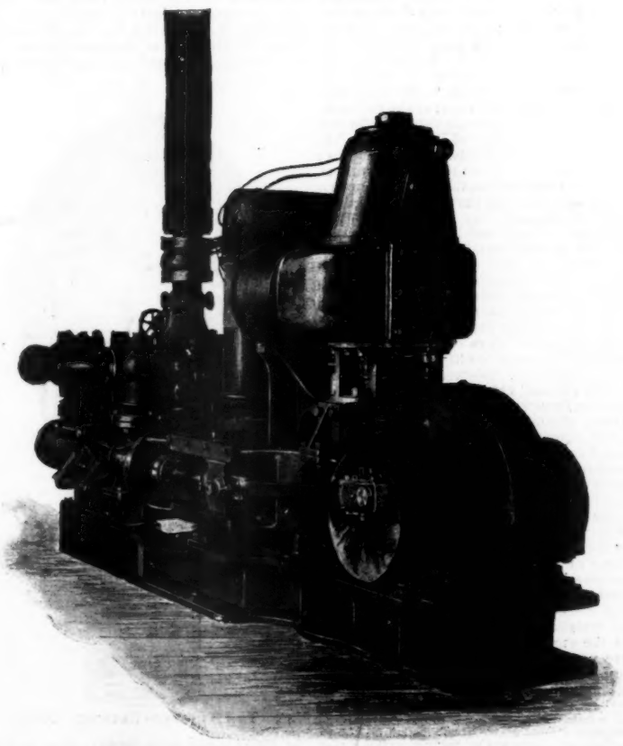
Hon. John Francis, for several terms State Treasurer of Kansas, and afterwards largely interested in electrical railways in the West, is now engaged in the banking business in New York city as vice president of the Inter-State National Bank, 167 Broadway. Through the efforts of Mr. Francis, his bank has been appointed the fiscal agent of the State of Kansas, a highly responsible and very desirable appointment. Mr. Robt. Weems, the president of the bank, is widely and favorably known in banking circles, and is a gentleman of financial ability and excellent judgment. These gentlemen have associated with them Mr. F. F. Stone, an experienced cashier, and a careful board of directors, and their bank, although a comparatively new one, has taken high rank among the financial institutions of New York.

Condenser for Alternating Current Motors.

The low efficiency of alternating current motors is known to be due to the large self-induction due to the iron. This self-induction, by creating a greater amount of current lag in the field magnet than in the armature circuit, changes the times of magnetization of field and armature, respectively, resulting in an inefficient operation. With a view to decreasing the amount of lag and



bringing the instant of field magnetization more nearly into coincidence with that of the armature, William Stanley, Jr., of Pittsfield, Mass., and John F. Kelly, of New York, propose to insert in the field magnet circuit a condenser. The improvement is illustrated in the accompanying engraving, which represents an ordinary shunt wound motor, provided with laminated field magnet and armature cores, a condenser D being interposed in the shunt or field magnet circuit. The condenser has the property of neutralizing or counteracting the effects of self-induction in the circuit with which it is connected. The high self-induction of the field is thereby lowered, and its time of magnetization brought more nearly into coincidence with that of the armature. It would seem at first sight that the enormous resistance added to the field magnet circuit by the condenser would reduce the field magnetization to a very low value.



25 Horse-Power Edison Electric Mining Pump.

.... An agreement has been recorded whereby the Baltimore & Ohio Railroad Company agrees to sell all its telegraph lines to the Western Union Telegraph Company for $5,000,000.

TELEGRAPHIC

.... Farmington, Me., is being supplied with a system of electric fire alarms.

.... The Postal Telegraph Company has commenced the construction of a line between Fostoria, Ohio, and Detroit, Mich.

.... The Postal Telegraph Company has sued the city of New Orleans for $60,000, for cutting down the company's poles and wires.

.... The Postal Telegraph and Cable Company are laying down a new telegraphic cable across San Francisco bay, and are also making shore connections.

.... The East Orange, N. J., township committee has directed the New Jersey Postal Telegraph Company to remove all its wires from the township within 30 days.

.... On July 1, the United States Weather Bureau was transferred from the Signal Corps of the Army to the Agricultural Department. Prof. M. W. Harrington, of Michigan, has been appointed chief of the bureau. The telegraph and electrical division is under the supervision of Mr. E. L. Bugbee, who has an able corps of assistants, with J. H. Robinson as his chief operator.

.... An order was entered in Judge Blodgett's court, at Chicago, July 10, confirming the sale by Master in Chancery Bates, in New York, of the American Rapid Telegraph Company, to a committee representing the bondholders. The consideration is $100,000. The lines are operated by the Western Union Telegraph Company, and it is understood that the purchasers really represent that company. The claims proved up against the company aggregated $4,156,000. This ends a litigation extending over 10 years.

PERSONAL.

Mr. D. H. Bates sails for Europe this week on the "City of Paris," to remain abroad until October.

Mr. W. A. Stadelman, the handsome and energetic electrical engineer, of Philadelphia, was a New York visitor last week. Mr. Stadelman is at the head of a progressive engineering company in his city.

Mr. John M. Fox, until recently with the Eureka Electric Company, of this city, will shortly open an office of his own in Portland, Me., where he will be glad to receive contracts for all kinds of electrical engineering work.

Mr. E. D. A. Brady, 56 West One Hundred and Sixth street, New York, has just been appointed electrical engineer of the Frackville & Gilberton, Pa., Electric Light, Heat and Power Company, who will install an extensive plant.

R. R. Bowker, litterateur, reformer, mug wump and exquisite, is now so deeply immersed in business life that he hasn't time to look out for what used to be the inevitable pink in his buttonhole. He's looking out for the Edison interests, and doing it as well as if he never had written a line in his life and never had been a reformer. He says, however, that he's just as much of a mug-wump as ever.—*New York Morning Advertiser.*

Mr. Charles A. Schieren left last week on the steamer "Fuerst Bismarck," for a short trip in Europe. He will visit the International Electrical Exposition at Frankfort, where he will inspect the various devices for transmitting power by belting exhibited there. From a recent letter, Charles A. Schieren & Company learn that the American leather link belt exhibited at Frankfort by the American Leather Link Belt Company, attracts universal attention, and is so much superior to all European link belts exhibited that the other exhibitors have withdrawn from the Exposition.

THE INCANDESCENT LAMP.

(Continued from page 287.)

respects to the defendant's experts, and shows how they had doubled on their tracks since the McKeesport case, changing their opinions with a change of client. In regard to the definition of the term "filament," a mathematical certainty of definition is not necessary. The contention of the defendant that it meant a burner of at least 100 ohms resistance hot, was intended to open a way to lamps designed for alternating circuits, which could be made of 50 or 60 ohms resistance. A lamp made in the proportions of the model of the Edison patent measured 80 ohms cold and 40 ohms hot. In comparing the filamentary burner with the rod burners, the largest filamentary burner bears the relation to the smallest rod burner of 27 to 244 in extent of surface per unit of resistance, and if to this be added the difference in specific resistance, which was only fair, it would be found that the smallest filament in the patent would be worth 2,500 times a millimeter rod for commercial lighting. Mr. Edison was entitled to a broad claim for the combination of a carbon burner of any dimensions with a vacuum chamber of this particular character. The scope of the invention was broader than the filament. The patent was limited to that, but on the broader ground of his discovery of the stability of carbon a liberal construction should be given to his claim. The lamp of Dr. Adams, discovered by the defendant at the last moment, was an absolutely abandoned experiment not worth dwelling upon. No sample was preserved or publication made. A patent was applied for in 1882, rejected upon Edison's patent, the rejection accepted and the claims restricted. Whatever else it might have been, it was a lamp of large radiating surface and low resistance.

General Samuel A. Duncan for the U. S. Electric Lighting Company.

It will be well at the outset to get a clear conception of the problem Mr. Edison undertook to solve in connection with electric lighting. The bill of complaint stated that it was inventing a complete system of lighting capable of competing with other forms of illumination, involving the perfection of many distinct apparatuses. He was early in the field, backed by a powerful syndicate, and in November, 1882, had no less than 150 patents relating to this system. Other inventors were at work contemporaneously upon the problem. Mr. Hebard says his company owned 131 patents in 1885, yet the proposition is, that a single one of the Edison patents controls the situation, and is to throttle this magnificent industry. The tens of millions of dollars invested by other companies is to be destroyed by this one patent, which is but a single element of the general system. His position was that this patent produced no impression on the art. This was not the only suit pending in this court by this plaintiff, there were 29 others, involving a dozen of their multitudinous patents; several of which were also styled "fundamental patents." If this suit failed, they would doubtless claim that the other patents solved the problem of electric lighting. The statement in the patent that previous efforts have been made to reduce the resistance of the carbon-rod could mean but one thing, that they had undertaken to reduce the specific resistance of the burner, and not the total resistance. High total resistance was and always had been known to be desirable for a burner, whether used in series or multiple arc; when connected in series relation a point was ultimately reached, requiring a current of so high electromotive force as to be dangerous in multiple arc arrangement; there being no increase of electromotive force, the individual lamp resistance must be made much higher. This principle might be carried to the uttermost, the only limitation being to keep down the radiating surface. It was recognized from the start that a high total resistance was desirable; in the Morse telegraph a high resistance coil was used to concentrate the energy at the point where the work was done. Electric lighting was on a par with all other means of applied electricity in this particular, and the man who in '78 could not apply these rules could not be considered skilled in the art. In considering the state of the art he said "the Geissler tube shows a receiver made entirely of glass, having fine platinum wires conducting the current into a highly exhausted chamber. One form of the Crookes radiometer was the Edison lamp of the patent in suit, except for the carbon filament; there was the high vacuum, the all-glass globe, the fine platinum leading-in wires, and the burner inside. An application filed by Freeman in the United States Patent Office, in '81, showing an incandescent lamp with a carbon burner in an all-glass globe, highly exhausted, with platinum leading-in wires, was put into interference with this very patent of Edison's, but it was afterwards rejected by the Patent Office on reference of Crookes' radiometer—the office holding:

"It is not deemed material that applicant claims a carbon filament, in the place of the platinum conductor shown in the reference, the substitution of one for the other being a matter within the skill of one well versed in matters pertaining to electric lighting; it being old in the art to use carbon conductors for incandescent lamps."

Certainly this would have been as pertinent a reference against Edison if it had been known to the Patent Office when his case was pending. King's patent of '45 describes platinum so thin that the letters of a printed page could be read through it. King described the use of carbon, and specified that it should be enclosed in a vacuum. The Roberts English patent speaks of a burner of a very thin graphite, "as thin as can be conveniently made," to be used in "as perfect a vacuum as can conveniently be made." Edison took out a French patent in '79 for a platinum lamp strikingly like the carbon lamp of the present patent. It contained a highly exhausted glass chamber with two platinum leading-in wires sealed by fusing; and connected in the exhaust chamber with a great length of fine platinum wire coiled. This was part of the state of the art when the present invention was made. In the French patent the relation between size and proportions of burner are specified.

THE A. B. C. LAMP.

This being the case, there could be no invention in subsequently applying the same rules to a lamp differing only in the material for the burner. It was merely a question of electrical engineering. He did not feel called upon to state whether the platinum lamp was a practical lamp. Edison and others found that carbon was a better material than platinum, and it had been known beforehand; but there was a difficulty in manipulating carbon to get a sufficiently high resistance. A wide field was open for all, but if Mr. Edison, by rolling lamp black and tar into a fine wire and carbonizing it, could make high resistance wire, he was entitled to a patent for it if it was new; but the great principle of the relation between high resistance and small cross-section of the burner and the amount of copper required to carry the current from the dynamo to the lamp, was not, and could not be, a part of the patent in suit. Khotinsky's French patent of '75 and the United States patent of Woodward in '76, show incandescent lamps in multiple arc; and the Lane-Fox patent revealed as fully as Edison's French patent, the relation between high resistance in the burner and amount of copper in the conductor. Sawyer-Man early in '78 operated with small carbons—some of them but a sixty-fourth of an inch in diameter, much smaller in cross-section than many of the commercial lamps of to-day. Summing up the prior state of the art; the utility of carbon as a burner was known, so was the receiver entirely of glass, the use of fine leading-in wires of platinum, the arranging of lamps in multiple arc, the necessity of high total resistance in the burner, the idea of small cross-section of the burner, the manufacture of carbon by carbonizing a mixture of lamp black and tar. The specific way of securing the filament by carbonizable cement appeared to be new with Mr. Edison. Another possible feature of novelty was the carbon of a total resistance of 100 ohms. There was probably nothing patentable in that, but the patent laid stress upon it; and they were not disposed to contest the novelty of that. Another point of possible novelty was the coiling of the filament into a close spiral. The questions put to Mr. Edison to ascertain whether he believed that he had made a great discovery as to the relation between high resistance and small radiating surface, and the amount of copper in the surface, were not answered in a frank and manly manner, as the following extract from his testimony showed:

Q. "Do you consider yourself the discoverer of that relation?" A. "I do not consider myself the discoverer of Ohm's law. It will explain all things that have been done and probably everything that will be done in the next 1,000 years in electricity." Q. "I ask you whether you consider that you are the person who discovered the relation between the size and proportions of the burner and the character of the conductors conveying the current to each lamp, when being used in multiple arc?" A. "I do not know whether I am or not in relation to an incandescent lamp. Ohm's law does not mention incandescent lamps. It is a general law." So he went on and presently began to quarrel again with Ohm's law: Q. "Didn't you know as a matter of inference from Ohm's law, that with a given size of conductor it would be necessary to give the individual lamps a higher resistance if they were to be used in multiple arc, than if they were to be used in series?" A. "It is not necessary in applying Ohm's law at all, but when you bring in the commercial element then it is; *the fact of the matter is, that at the time I experimented on the incandescent lamp I did not understand Ohm's law.*" Q. "Do you mean that you did not know the formula of Ohm's law at that time?" A. "No, sir; I did not know it." Q. "When did you first get knowledge of Ohm's law?" A. "*It may seem strange for me to state that I do not understand Ohm's law today.*" Q. "I do not ask you whether you understand it, but when did you first know of it?" A. "I have heard of Ohm's law for the last 20 years." Q. "What do you mean by saying that you did not know Ohm's law at the time you began experimenting with incandescent lamps?" A. "*I mean to say that I did not understand Ohm's law, I do not understand it now and I do not want to understand it. It would prevent me from experimenting.*" Q. "Why?" A. "Because I would try to figure it out mathematically. *I have employed a great many mathematicians; they have all been dead failures.*" Q. "Does that include Mr. Upton?" A. "Yes, sir; in his mathematical capacity."

Mr. Edison flies into a quarrel with one of the great laws of nature. Were they to believe that he, of all men, could not understand one of the fundamental laws of electricity taught to children in primary schools? It was incredible. It was his method of avoiding an answer to the question, nothing more.

The defendant's position was that the lamp of this patent was an inferior structure and made no more impression on the art, than the platinum lamp of '78, which caused a great panic of gas stocks in London. There was no evidence that a single tar putty filament such as described in this patent, was ever put in commercial use. It was not Edison's lamp that solved the problem; it was a system of distribution for which the world had been waiting. There were three points in Claim 1 demanding special attention. The filament is to be made of carbon of high resistance; it is to be made as described; and it is to be secured to metallic wires as set forth. All the witnesses were agreed that high resistance means high specific resistance; and the standard by which to measure specific resistance is that of the old carbons. The question as to infringement, then, was whether the defendant's burners are made of carbon as high or higher than the standard set up by this patent. They contended that the conditions in Claim 1 were that the filament is to be made by carbonization without any supplementary process to induce a lower resistance. The third condition meant the application of a carbonizable plastic material to the joint and carbonizing it *in-situ*. As to the word filament; he did not know what it meant. If it meant a 100 ohms total resistance in action, defendants were outside of the second claim, as regarded two of their lamps. The term never appeared in the art, until used in this patent, and the patentee was under every obligation to define the term with exactness, but the whole thing was vague and uncertain. General Duncan then referred to an application filed by Mr. Edison later than the issue of the patent in suit, for a burner of carbonized paper, which was put

THE THOMSON-HOUSTON LAMP.

in interference with Sawyer-Man and defeated. The part not involved in interference was made the basis of a divisional application containing a claim for a filament of high resistance of flexible carbon hermetically sealed within and enclosed by a globe made entirely of glass. The claim was rejected by the Patent Office. That application threw a bright light not only on the interpretation of the patent in suit, but threw a side-light strongly on the laches of the plaintiff in bringing suit. During the period of from '80 to '85 an active competition was going on. Major Eaton said that the reason suit was not brought was that the defendants were not doing enough harm—that was simply childish. The explanation was, that they did not believe, during those years, that the patent in suit was the fundamental patent which they now asserted it to be; and did not bring suit until their application had drifted where they felt powerless to secure what they originally asserted under it to be their rights. In conclusion, the defendants contended that the patent did not meet the stern requirements of the patent law. The invention was not described in such terms as would enable a person skilled in the art to make and use it. Nor was the best mode of applying the principle set forth; nor was it particularly pointed out and distinctly claimed, as required by the statute, what was new. There was no definition of the term filament, and complainant's experts had shown themselves utterly incompetent to define it; so of the word carbonization. If the Furness method was the only one known to him at the time it would not be necessary, because Mr. Howell had to resort to a method of carbonizing, to make a test lamp, which was not known at the date of the patent. It came, therefore, to this, on the testimony of Professor Thomson and the experiments of Mr. Howell: The Edison Company practically confessed it as impossible to make the thing described in this patent without resorting to practices not known at its date of issue.

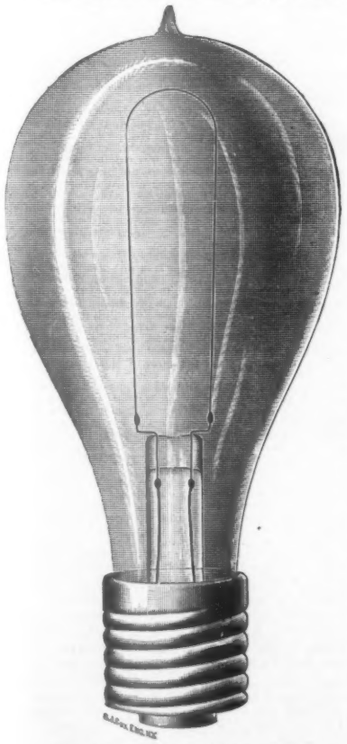
Mr. Seward for the Edison Company.

The two questions which actually presented themselves for adjudication were, is the Edison patent valid, and did the defendants infringe it? These were two questions of fact, whether the patent is valid upon its face, or whether it describes sufficiently the *modus operandi* and construction. His Honor had not been shown in the art or antecedent patents anything which covered this invention, except that he would be expected to find the invention of Mr. Edison in the Sawyer-Man discoveries, inventions, patents, labors and experiments. Somebody had evidently made an invention which rendered incandescent lighting possible, and whoever made it ought to have the credit of it. Every successful lamp had a burner of filamentary form, small cross-section and radiating surface, high specific resistance, sufficient stability to resist disintegration, sufficient elasticity to resist shocks, and capable of expanding by heat without injury to its substance. Each of these features were purposely originated by Mr. Edison or selected from the arts as a unit for his combination, and for the first time a practical subdivision of the electric light and its use in multiple arc had been sucessfully accomplished. Did Mr. Edison make this invention? No one else claimed to have done so, except Sawyer and Man. What was needed in all the prior lamps? They contended it was a filamentary burner or carbon arranged and combined as described in this patent. If this was not due to Mr. Edison, to whom was it due? No answer had as yet been given, apart from Sawyer and Man, by the ingenious friends on the other side. They asserted that the success was in the lamp. All outside improvements that were made were simply for the purpose of utilizing the successful lamp given to the world by Mr. Edison. The defense says that Mr. Edison surreptitiously obtained a patent for that which had been invented by Sawyer and Man; so when Sawyer and Man made their incandescent lamp it was an invention. But when plaintiff put it forward as Mr. Edison's invention then it was no invention at all. The only practical question with which he would trouble his Honor was this: Did Sawyer and Man, in their efforts to produce a burner of any sort, succeed in producing one which could be successfully used, of a filamentary form having a small cross-section with small radiating surface and high resistance? The word "filament" conveyed a sufficiently accurate idea of what it was intended to describe, to both the educated and the uneducated mind. It was a quantity of carbon having a small mass, small cross-section, and sufficient specific resistance to accomplish the purpose of giving light by incandescence. Quoting from the testimony in behalf of Sawyer and Man, it had clearly proved that they had not intended to use a burner with high resistance. They were seeking to find a carbon which should be stable in form and would remain stable under the heat of the current. They never made it, never used it, never claimed it, and if they did not no one else whose name had been alluded to did make, use or describe it. He would next say a word or two upon the law. It was asserted that the plaintiff lost the right to an injunction, even if the patent were valid, by acquiescing in what defendants had done. The patent was issued in January, 1880, the suit was commenced in May, 1885. The only overt act charged against the plaintiff was that it had not sooner commenced the suit. If there be anything in such a defense it should have been pleaded; not having been pleaded, it could not be availed of at any time. As a matter of fact, there had been no laches. During that interval of five years the plaintiff was under a cloud, created by the decisions then existing, declaring that a prior five-year Canadian patent would cause the American patent to expire at the end of the five-year term. Their suit had been met with that plea, sustained by his Honor, and it took two years

to get through the Supreme Court with the Bate case, in which it had been decided that the patent in suit had not expired, therefore, this suit was premature as it was. In the meantime, they were prosecuting suits in France and England. It was contended by the defendants that a subsequent Swedish patent had expired, and that it had the retroactive effect to kill the prior Canadian patent, and through that to kill the patent in suit. The Swedish patent had not expired, and even if it had it would not necessarily affect the Canadian patent. Defendants asserted that Mr. Edison's discovery was not an invention, but a mere result of electrical engineering. It was argued by his brother Duncan that it only required the application of known rules of electricity. Unable to separate the knowledge of to-day from the knowledge of 1878, what had been done seemed now so simple and easy as not to require any exercise of the inventive faculty. In a similar case Judge Blatchford said: "It is easy now, after the event, for scientific men to say, with the knowledge of to-day, that the thing was obvious, but the crucial facts contradict the assumption." What were the crucial facts here? First, there had been a pressing necessity for a successful incandescent lamp; the ingenuity of Sawyer and Man had been directed to gratifying it, but until Edison had given to the world his attenuated burner in a vacuum, the necessity remained unfulfilled. Second, the literature of the art, and the record of past experiments, would have deterred any less courageous, less persistent, less confident inventor than Mr. Edison from making any further experiments with carbon. But he had put aside the experiments of others, the instruction derived from literature, and traveling in his own way, to his own end, he had found that carbon could be produced in such a manner that it was stable and sufficient for the purposes of a commercial lamp. He had given that to the world as his contribution to the science of incandescent lighting.

Mr. Betts for the U. S. Company.

Mr. Betts discussed the bearing of the foreign decisions on the present controversy. He thought in the case in which the patent was sustained, it was with hesitation. Mr. Justice Fry had said: "The description is so far from as clear as it might be, that we at one time doubted whether it was not studiously and wilfully obscure." The courts were also very doubtful on the question of novelty, in view of the experiments of Swan. Swan's carbons were considerably larger, but



THE EDISON LAMP OF TO-DAY.

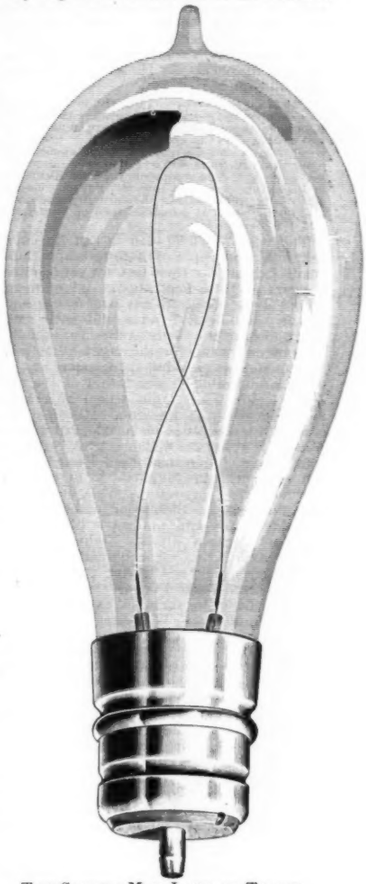
the courts were inclined to think it was merely a matter of degree in attenuation. If the English decisions were any authority upon construction, the first claim was not infringed. Justice Butt thought the second claim depended on the meaning of "carbon filament" and thought the resistance must be not less than 100 ohms, that it must possess flexibility and resilience, must be of small cross-section, of high resistance, and presenting small radiating surface. The appellate tribunal had construed the patent in somewhat broader terms and held that high resistance was an essential feature. If this meant high specific resistance, the case was easily disposed of, for any carbon burner had high specific resistance compared with platinum, and the invention must be narrowed to a particular kind of carbon, and there could be no intringement, as defendants used carbon of low specific resistance. He thought the English court did not mean this, however. They considered the total resistance must be high to render the lamp a commercial success. It could not mean "high" relatively to the rest of the circuit, because that was old in every prior lamp, from the very law of its operation. Did it mean high resistance relatively to the old lamps mentioned in the patent? The English court thought Edison meant to include all lamps having a resistance higher than four ohms; but the Sawyer-Man, 1878, patent referred to lamps of 10 ohms. The only other definition left for "high resistance" was this: That it should be so high as to enable lamps to be commercially used in large numbers in multiple arc, and that meant, as proved on both sides, that each lamp must be 100 ohms. The English justice who gave the prevailing final opinion in the final case defined "filament" as a carbon bent into form before carbonization. It was doubtful whether this would be infringed, as defendants' carbons were not bent but were stamped from sheets. The complainant could not rely upon either of these tests in the present contention. The patentability of high resistance was exhausted in the French patent. Complainant's experts say high total resistance is not essential to the lamps of the present patent. (A sample case of Edison lamps were shown all stamped with the number of this patent, some of which had only ½ ohm resistance.) Those of ½ ohm resistance are claimed to be as much within the patent as anything else. Mr. Clarke had admitted that in 1879 resistance was simply a question of where the lamp was to be used, and his testimony proved that the invention lay in making a durable carbon. The bent form of carbon was used by Sawyer-Man in 1878, a fact not presented to the English court, so that the complainant could not rely upon either of the points relied upon in the English courts. So that the conclusion was hard to resist that if the present proofs had been before them, the English courts, if they had sustained the claim at all, would have given it a narrower construction. That was the state of facts in the German case, and Edison was there held to the specific thing described: A coiled carbon incandescing conductor of high resistance and small radiating surface. Having abandoned the two points relied upon in the English case, the complainants now sought refuge in the supposed discovery of stability of the carbon. The attenuated form of the carbon could hardly give it stability; it was so because enclosed in a vacuum—without access to oxygen. Several of the early patents stated that the vacuum should be as high as possible. With the Sprengel pump came a better vacuum, but the early imperfect vacuums had done as much to render carbon stable as the more perfect later ones. The statements in the patent that Edison had "properly" carbonized cotton and linen threads, etc., added nothing to the art. The question was *how* to carbonize. Mr. Edison's associate, Mr. Batchelor, had testified that in 1880 (long after the date of the patent) they were not using a known process of carbonization. Now, if the patent did not teach some method of carbonization, what information did it add to the public? Mr. Edison deserved credit for the bamboo lamp, but that was a subsequent discovery, and, as Justice Kay said in the English case, could hardly support a previous patent which had not described it. By stipulation, the Lane-Fox patents were given a date of publication October 18, 1879, three days before Mr. Edison claims to have made his invention; a narrow margin, but as good as three years. He contended that Lane-Fox had anticipated Edison by pointing out an incandescent lamp containing a carbon conductor of high resistance and small radiating surface, enclosed in an all-glass vacuum chamber. The result of all these inquiries was that the invention ought to be limited to the specific thing made as described and not extended to all successful carbon conductors.

Mr. Wetmore for the U. S. Company.

Referring to the prior state of the art, there were two facts to start with: 1st, the date of invention in this case was fixed beyond controversy at October 21, 1879; 2d, at that time the invention disclosed in Mr. Edison's American platinum patent had passed into the prior state of the art, because a French patent, fully describing it, had been issued before the present invention was made, and by established authorities, when a patentee had described an invention, he could not make it the subject of a subsequent patent, unless he had announced his intention of so doing in the prior patent. It was known at the date of the present invention that the resistance of a conductor depended upon its specific resistance and its shape. As to material of construction, but two were known—carbon and platinum. Carbon was used in all of the early lamps, because it was known to be stable and infusible. The Adams lamp was a striking instance that it had been known that a conductor of extreme tenuity had a high degree of stability when enclosed in a vacuum chamber. It being known that stability was a property of carbon, and that the more perfect the vacuum, the larger its life; it was immaterial that any one should discover the precise degree of tenuity which was best. Invention might lie in giving the carbon a high resistance, or in making it in the form of a spiral. The statement of invention in the patent was misleading, because it ignored the King (Scott) lamp. The reversing of the previous practice referred to in the patent was misleading, because that reversal had already been made. The patent was not explicit and consisted of a number of disjointed statements as to what Mr. Edison had discovered, insufficient to enable the invention to be carried out. Mr. Wetmore analyzed the patent, sentence by sentence, and concluded that the specification gave a definite meaning to "filament" as "a piece of fine high resistance carbon coiled into the spiral conductor of the patent." The plaintiff had gone into the Patent Office with a divisional application after this patent was granted and asked for another patent on the ground that this patent was expressly limited to this narrow construction. If their present construction of the patent were right they could not have that claim, because it involved a conductor precisely like the one which they claimed infringed the present patent. The construction they seek to put on this patent and the pending case could not both be valid. They reasoned if they lost the suit they would have a clear patent; if they won the suit they would not use it. These two inconsistent positions cannot be taken in a court of equity. The appalling claim made by the plaintiffs was extremely unjust. The defendant had been in business since 1880; had put a million and a half dollars into it; were selling over a million lamps per annum. They had pursued this course for five years without hearing of such a claim as has now been urged. During this time the effort was made to issue from the Patent Office the pending application. Finally, on failure there, they unmasked this battery and said: "Here is the claim on which we seek to embrace the whole field." Could the patent be upheld on this theory against the $20,000,000 invested capital of the Thomson-Houston and Westinghouse Companies; wreck private fortunes; throw large corporations into bankruptcy, and have placed in their hands a monopoly so vast that in any other country except one with an all-abiding sense of law, the result would be a revolution? That was their position and they asked the court to construe the patent, against their own solemn admissions, more broadly than any of the famed electricians within sound of his voice would ever think of construing it.

Mr. Lowrey for the Edison Company.

This was a great controversy. The truth of history was in issue, and future generations had a right to know it. He represented a man whom most of the world considered a great inventor and benefactor. The few remaining who still persisted in the contrary belief were nearly all present in that room, or in the record as witnesses for the defense. The question was now presented, whether such an inventor, after years of struggle and endeavor, in full view of the great benefits conferred by him on mankind, could, by a petty parsing and spelling of things, a subtle analysis of sentences composed in a patent solicitor's office, lose the invention he had given to the world. Mr. Edison was a character unique in the history of the art. Endowed by nature with the rarest faculties of observation, capable of realizing beforehand all that was to take place in any hitherto hidden physical action, with highest courage and enthusiasm, indomitable energy, capacity of concentration equal to that of the microscope, a man whose modesty and intellectual honesty were as monumental as his constructive genius. No wonder he had startled the idiots of the schools and excited the animosity of men who teach to unresisting boys the knowledge as well as the errors found in books. Edison had been an inventor by nature. His first thought had been a question; his constant tendency to remedy that which was deficient. He was not to be spoken of as an electrical engineer, nor yet as a philosophical discoverer. He was a commercial and industrial inventor whose sole object was to make things useful to mankind, taking his fair reward as every laborer took his hire. To him an abstract principle, incapable of being applied to ameliorate some conditions of human life, was as valueless as a cup of water thrown into a lake. That was the kind of a man who had been treated with contempt by the other side, and who stood for the moment with a chance of losing his invention by some trifling pen-and-ink business in the shop routine of a patent solicitor's office. Mr. Wetmore's statement as to what was said in another application derogatory to this patent had been inserted entirely without Mr. Edison's knowledge. That application had been held by the Patent Office to be identical in invention with the patent in suit. There was a judicial construction that the patent in suit was like the application upon which Mr. Wilbur had sought to obtain for Mr. Edison a patent. Mr. Lowrey then considered at length the pending divisional application, and contended that Edison's act in making it could not in any way aid a construction of the claims of



THE SAWYER-MAN LAMP OF TO-DAY.

the patent in suit. The facts would show that 13 months after making the present claims Edison had come to fear that they might be construed more narrowly than originally intended, and to believe that he ought to protect his invention by a subordinate patent. His brother, Betts, criticized the English decisions on the ground that they were good enough for the facts they had, but would not serve for the facts here. Evidently all the English cases had not been examined. Extracts from the English decisions were then read, with comments, Mr. Lowrey observing that Mr. Betts had supported the corner-stone of his criticism upon the erroneous assumption that the English courts had not heard of the platinum patent, but that it must now be carted away and tumbled into the dock.

There was a class of men who, from seeing a thing done, were able to believe that it ought always to have been done. Doctors Cross and Morton had constructed for his Honor's benefit, a lamp out of the laws of nature. His Honor would not be able to read by it, but it was a good enough lamp for purposes of litigation. They had built it up from what one man knew about resistance; another man about sealing glass globes; and they said now that it was entirely obvious that anybody could have made such a lamp if they had really a call to do it. Mr. Betts had said that the whole subject of arranging lamps in multiple arc and series, and the making of incandescent lamps of 10 ohms resistance, was in the Sawyer-Man patent of 1878. That is a total misapprehension of the patent. It was principally a patent for a switch, and stated that the resistance of the carbon when hot, was 10 ohms, and when cold, *nil*; an entirely erroneous idea. Half considered guesses were put on paper and filed in the Patent Office. Even as late as 1879 the matter of the difference in resistance between hot and cold carbon had not been definitely ascertained. Starting out with Edison, in 1878, upon his memorable search which resulted in the finding of the incandescent lamp, you would find that Morton, Preece and others, in fact, all except Sir William Thomson and Dr. Tyndall, were committed to the statement that

he was on a fool's errand. They had written across the path "No thoroughfare," and had signed it "Mathematicus." The great authorities in electricity and mathematics did not seem to be able to get outside of their figures and equations. Professor Cross and Professor Morton professed to know what was not invention, although there is nowhere in the world evidence which would convict either of them of inventive capacity enough to hang a tin dipper on a pump. Yet they had been called up with their pencils and little pads, to figure out that an invention like this—for which the whole world had been waiting—was after all no invention at all. Prof. Sylvanus Thompson was a striking example of this class. He wrote in a letter the following:

"Much vagueness appears to exist in the minds of men upon the possibility of dividing the electric light indefinitely, and much has recently been said and written upon the question, which, if tested by sober reason and the application of elementary dynamical principles, will be found to be sheer nonsense. * * * The reporter in the New York *Sun*, in his enthusiasm, puts into Mr. Edison's mouth statements which exhibit the most airy ignorance of the fundamental principles both of electricity and of dynamics."

This was the first man to call Edison a fool. The principle of high resistance and small radiating surface had not yet reached the ears of these gentlemen. All of them were "away off" from any true conception of the real difficulty, and would have staid away off forever. There had been absolutely no progress made in the right direction. What defendants said about the state of the art was admirable because it told of the absolute nothingness from which this man started in the right direction. His direction was high resistance, and he achieved it by a filament. What was a filament? A very thin long thing. There had been King, in '45, who had a thin long ribbon of carbon; one could read through it. Well, one might read through a ribbon of carbon for a thousand years and not get a filamentary structure for an electric light. Edison sought high resistance accompanied by low radiating surface, and having put the two together, could cancel the orders on the copper merchant, to such an extent that he could get money in Wall street with which to do business.

Mr. Lowrey then traced the development of Mr. Edison's invention and his efforts with carbon and platinum. After the publication of the discovery in regard to the carbon filament, Mr. Sawyer offered to bet a large sum of money that they would not last 20 minutes. Mr. Lowrey then discussed the several law points in the case, and showed the fallacy of Mr. Wetmore's claim that the French platinum patent was a prior state of the art when Mr. Edison applied for the patent in suit, and that if it might operate as such to a stranger, it could not to the same inventor, under Statute 4,887. There were exceptions to the rule that it does not involve invention to substitute superior for inferior materials, and this case comes within the exception. Assuming the perfect identity of the invention covered by the first and second claims with the prior platinum lamp described in the French patent, the fact that the invention in the patent calls for carbon, carried this case away from the rule as the substitution of carbon involved a new mode of construction and developed new uses and properties in the lamp. In regard to the charge that there was no invention in change of degree, the decision cited in support of this involved inventions in which such changes had some utility, but in which it was obvious before the changes were made that the beneficial result could be obtained in that way, but in a case like this, where the reduction of cross-section and increase of length operated accumulatively, and enormously increased the resistance, the change was revolutionary upon the entire system of incandescent lighting. The difference between the old and the new lamp may be made to shade off into each other, as Justice Lindley said, until it is impossible to draw a line sharply between them, but this does not prevent a man from seeing the difference between two types or from adopting the one which succeeds in preference to the one which fails. The defendants held that the first claim should be limited to the spiral form of the carbon, and that this limitation comes within the words "made and described." The third claim of the patent calls especially for the coiled form of carbon. If the first claim were construed as calling for a coiled form then there would be two claims identical in scope. Mr. Lowrey then discussed the argument that the patent was limited to a filament of a hundred ohms. It was absurd to suppose such a thing. The resistance varies according to the candle-powers. Mr. Edison never meant to say that he would never make small lamps, which would necessarily have less resistance than the larger ones. All that the patent called for is a greater resistance compared with a former resistance of one to four ohms. But even admitting that there is ground for importing into the first and second claims this limitation, they were still so abundantly broad that it is unnecessary to invoke that charitable rule of construction which courts apply to patents to enable inventors to reap the due rewards to which they are entitled. The contention that the patent is void because the description is not sufficiently full and clear was totally swept away by the proofs. Mr. Wetmore had closed his argument with an eloquent appeal not to punish by a severe application of law the 20 millions of capital invested in this business. "If your Honor believes for one moment that the people who put their millions into infringements did not know what they were about, you have not apprehended the clearness that prevails with regard to such matters in Wall street. People who have money to invest see intuitively how much it is worth while to risk in an unlawful course for a great profit—how large a sum of money it would pay a man to go to jail for—and they take their chances; they know what they are about, and do not require the protection of any court in that respect."

THE OPINION.

THE EDISON ELECTRIC LIGHT COMPANY *vs.* THE UNITED STATES ELECTRIC LIGHTING COMPANY.

Circuit Court of the U. S. for the Southern District of New York.

WALLACE, Circuit Judge:

Two claims of Letters Patent No. 223,898, granted Thos. A. Edison, January 27, 1880, for an improvement in electric lamps, are in controversy in this suit. These are Claims 1 and 2. It is not asserted for plaintiff that the defendant infringes the other claims of the patent, consequently, they will require no attention further than to see whether their terms may assist in defining the meaning of the claims in litigation.

The plaintiff contends that these claims are for fundamental inventions of great merit, and are entitled to a construction by which every incandescent lamp for electric lighting, consisting essentially of a filamentary carbon burner, hermetically sealed in a glass vacuum chamber, is within their terms. The defendant contends that unless the claims are limited to narrow inventions not employed by the defendant, they are invalid for want of patentable novelty. The questions of the validity and scope of the patent have been adjudicated in the courts of England and Germany with a diversity of opinion by the judges who have considered them. The specification is a perplexing one. The difficulty lies in its shadowy demarkation of the line between the essential and non-essential features of the invention described. It catalogues a number of discoveries which Mr. Edison has made; it sets forth some of the essential features of the lamp, and then it leaves to be found by inference from generalities what the elements are of the combinations included in the extremely elastic terms of the two important claims. Nevertheless, when a sufficient knowledge of the prior state of the art to which it relates has been acquired, the new departures from old devices which it describes, and which, presumably, the inventor proposed to incorporate into the claims of his patent, are reasonably apparent. The specification states that the object of the invention is "to produce electric lamps giving light by incandescence, which lamps shall have high resistance so as to allow of the practical subdivision of the electric light." The subdivision of the electric light is the concrete term for the division of the electric current into numerous small units and their conversion into luminous centers. By practical subdivision is meant a distribution and division of the current and its conversion into lights comparable with those of ordinary gas jets, on a scale and under conditions of convenience and economy adequate to a system of illumination for domestic purposes, of dwellings, cities, analogous to that of gas. Prior to 1879 there was no method known by which this could be done practically. The problem involved the perfection of devices for the proper distribution and regulation of the current as well as those for translating it into light. No reference to the pre-existing devices for generating electricity, conducting it to the translating devices, or regulating its pressure and quantity, is necessary, except to state that the principles governing the relation of the resistance of translating devices to the character of the circuit in which they are arranged, whether in series or in multiple arc, were well known to electricians and had been applied in various forms of electrical apparatus. There were two well-known devices for converting the currrent into light—the arc lamp and the incandescent lamp. In the former the current is forced to leap an air gap separating two conductors, usually of carbon, and in overcoming the resistance of the air space heats the adjacent surfaces of the conductors and produces a light of great intensity. In the latter light is produced by the incandescence of an electrical conductor, a conducting strip or burner placed in a continuous circuit through which the current passes and which develops heat by its resistance to the flow. The arc lamp was suitable for use in streets, open spaces and large halls, but its light was too concentrated and powerful for the illumination of dwellings or rooms of small dimensions. It was the generally accepted opinion of electricians that the hope of progress in the subdivision of the electric light was to be found in modifying the features of the arc lamp. The reasons for this conclusion need not be mentioned; it suffices to say that Mr. Lane-Fox in England, and Mr. Edison in this country, seem to have been the only notable dissidents, and each of them had expressed the conclusion that subdivision might be accomplished by the incandescent lamp when provided with a conductor of high resistance and small radiating surface arranged in a system of multiple arc. Lane-Fox had set forth the advantages of such a lamp in three patents granted to him in England, two in October, 1878, and one in March, 1879, and in a letter to the London *Times*, published in December, 1878; and Mr. Edison had done so in a patent granted to him in France, May 28, 1879, for improvements in electric lighting.

By arrangement in multiple arc no greater electromotive force is required for a large number of translating devices than for a single one, and the amount of current can be graduated to the number employed; consequently, a lamp with a conductor of high resistance can be utilized as efficiently as one with a conductor of low resistance. Higher resistance in the conductor permits the use of a weaker current, and, consequently, of smaller and less expensive main conductors. With a smaller surface of conductor less energy is required to produce a candle-power, and the small incandescent mass will radiate a moderate light, like the domestic lamp. Electricians knew how to make conductors of high resistance, and how to make them with a small radiating surface. They knew that with material of the same specific resistance the total resistance of the conductor could be varied by varying its length or cross section, high resistance being imparted by length and small section. They knew what materials were preferable, and what processes of treatment, to make conductors of high or low resistance. If they had only known how to construct a lamp in which the conductor would have adequate mechanical strength and durability for practical commercial use, while having the small radiating surface and high resistance desirable, there would have been nothing wanting, and electric lighting by incandescence would soon have been an accomplished fact. Although Lane-Fox and Edison had contributed to the state of the art the recognition of the principle that the conductor must have high resistance and small radiating surface, and each of them had embodied the principle in lamps for which they had severally obtained patents, neither of them had invented a lamp which satisfactorily met all the conditions of success, because a burner of the necessary materials, form and complementary adjuncts was yet to be devised. As to materials, experiments had been tried with platinum, iridium and alloys of these metals, and with carbon of various kinds. It was known that platinum, being a poor conductor, could be readily brought to incandescence by the electric current, but to do so it was necessary to raise it to a temperature very near the fusing point, and a minute increase would melt it. On the other hand, carbon was known to possess at an equal temperature much greater power of radiation than platinum, but the difficulty was that it would combine with oxygen at high temperature and rapidly disintegrate. It could only be used, therefore, in a vacuum which was practically unattainable. From the earliest lamp (disregarding the Geissler tube, because it has no burner in the true sense), patented in England by King, in 1849, to the latest examples, like those of Lane-Fox or Edison's platinum lamp, patented in 1878-9, the history of the art shows a variety of experiments to perfect a lamp in which a carbon burner or a platinum burner would have sufficiently long life for practical requirements. The result of these experiments may be succinctly shown by quoting two well-known electricians. Mr. Schwendler, in an article published in 1879 in the *Telegraphic Journal*, said: "Unless we shall be fortunate enough to discover a conductor of electricity with a much higher melting point than platinum, and the specific weight and specific heat of which conductor is also much lower than for platinum, and which at the same time does not combine at high temperatures with oxygen, we can scarcely expect that the principle of incandescence will be made use of for practical illumination." Mr. Sawyer, in a patent to Sawyer & Man, granted in June, 1878, said: "At the present day it is not new to produce a light by causing the electric current to heat a carbon conductor to incandescence in a vacuum, or in nitrogen, or in other gas; but no lamp has yet been devised which would be practically operative, and for these reasons: First, the methods which have been adopted for charging the lamp with the artificial atmosphere, such as a displacement of mercury, water or air by the gas, or the combustion of phosphorous in the lamp, are imperfect. A perfect vacuum is unattainable. Some oxygen or other element or compound remains in the lamp, and slow consumption or disintegration takes place, for the remaining gas or vapor other than hydrogen or nitrogen attacks the carbon, which, in turn, is decomposed, with a result of depositing some carbon upon the globe and setting free the oxygen to attack fresh carbon. Second, it has been found practically impossible, under the varying degrees of heat and pressure, to maintain perfect joints, and the result that expansion of the artificial atmosphere by the heat from the luminous conductor expels a portion of the same, and the contraction of the atmosphere upon cooling causes a portion of the external air to penetrate the globe, thus supplying oxygen which at the least lighting feeds upon the carbon. Third, the unequal expansion of the carbon and its holders has resulted in fractures of the former, so that, however perfect the atmosphere in the globe, the lamp has never been permanent."

The most advanced type of carbon burner lamps in 1875 were the lamps of Lodyguine or of Konn, and until the spring of 1879 lamps like those of the Sawyer & Man patent or the patents of Mr. Farmer. It was thought to be the merit of Lodyguine's lamp that it obviated the difficulty of the short life of the burner by using two burners, rods of diminished section, in the form of loops, in a glass receiver, hermetically sealed and filled with nitrogen, electrically arranged so that the current would be passed to the second carbon when the first had been consumed. Konn provided his lamp with five carbon burners in the form of rods or pencils, and devices for bringing them successively into circuit. In the lamp of Sawyer & Man the carbon burner was a rod or pencil maintained in a globe and its stopper (both of glass) were held together by a clamping device. In the lamp of the patents granted to Mr. Farmer, in March, 1879, the burner was a carbon rod or pencil inclosed in a globe filled with hydrogen or other analogous gas, and the globe was closed by a rubber stopper. In none of the lamps, except the one described in Mr. Edison's prior French and English patents of 1879, had any attempt been made to make the vacuum chamber wholly of glass with the parts sealed together by fusion, or to seal the conducting wires leading to the burner through the glass by fusion of the glass. The impracticability of maintaining a carbon burner under such conditions that it would be sufficiently durable has apparently so impressed those who were studying lighting by incandescence that as late as in the early part of 1879 both Lane-Fox and Edison were trying to perfect a burner of other material. Edison's burner, in his French patent of May, 28, 1879, was of platinum or platinum upon a bobbin composed of an infusible oxide, and Lane-Fox's burner, in his patent of May 14, 1879, was of platinum-iridium alloy, or of spiral strips of metal surrounding a tube of glass, fire-clay, steatite or lime, with the surface of the metal strips covered with asbestos or some refractory material.

This cursory view of the prior state of the art is sufficient for an intelligent reading of the specification. The specification describes the general nature of the invention as follows:

"The invention consists in a light-giving body of carbon wire or sheets coiled or arranged in such a manner as to offer great resistance to the passage of the electric current, and at the same time present but a slight surface from which radiation can take place."

"The invention further consists in placing such burner of great resistance in a nearly perfect vacuum to prevent oxidation and injury to the conductor by the atmosphere. The current is conducted into the vacuum bulb through platina wires sealed into the glass."

"The invention further consists in the method of manufacturing carbon conductors of high resistance, so as to be suitable for giving light by incandescence, and in the manner of securing perfect contact between the metallic conductors or leading wires and the carbon conductors."

The specification then recites that previously light by incandescence has been obtained from rods of carbon of one to four ohms resistance placed in closed vessels in which the atmospheric air had been replaced by gases that did not combine chemically with the carbon; that the vessels holding the burner had been composed of glass cemented to a metal base; that the connection between the leading wires and the carbon had been obtained by clamping the carbon to the metal; that the leading wires have always been large, so that their resistance should be many times less than the burner, and generally the attempts of previous persons had been to reduce the resistance of a carbon rod. It then points out the disadvantages of such a lamp, stating that it could not be worked in great numbers in multiple arc without the employment of main conductors of enormous dimensions; that, owing to the low resistance, the leading wires have to be of large dimensions and good conductors, and a glass globe cannot be kept tight at the place where the wires pass in and are cemented, and consequently the carbon is consumed because there must be almost a perfect vacuum to render it stable, especially when it is small in mass and high in electrical resistance; and that the use of gas in the receiver at the atmospheric pressure serves to destroy the carbon by attrition.

The specification then states in substance that the patentee proposes a new departure; that he has discovered that even a cotton thread properly carbonized and placed in a sealed glass bulb exhausted to one-millionth of an atmosphere offers from 100 to 500 ohms resistance to the passage of the current, and that it is absolutely stable at very high temperatures; that if lamp black and tar, as a spiral and carbonized, or if a fibrous vegetable which will leave a carbon resistance after heating in a closed chamber be so coiled, as much as 2,000 ohms resistance may be obtained without presenting a radiating surface greater than three-sixteenths of an inch; that if such fibrous material be rubbed with a plastic compound of lamp black and tar, its resistance may be made high or low, according to the amount of lamp black placed upon it; that carbon filaments may be made by a combination of tar and lamp black, the latter being previously ignited in a closed crucible for several hours, and afterward moistened and kneaded until it assumes the consistency of thick putty; that this plastic carbon material may be rolled out in the form of wire as small as seven one-thousandths of an inch in diameter and over a foot in length, and the same may be coated with a non-conducting, non-carbonizing substance and wound on a bobbin, or as a spiral, and the tar carbonized in a closed chamber by subjecting it to high heat, the spiral after carbonization retaining its form; that he has carbonized and used cotton and linen thread, and splints, papers coiled in various ways, also lamp black, plumbago and carbon in various forms, mixed with tar and kneaded so that the same may be rolled out into wires of various lengths and diameters; that each wire should be uniform in size throughout; and all these forms are fragile and cannot be clamped to the leading-in wires with sufficient force to insure good contact and prevent heating; that if platinum wires are used and the plastic lamp black and tar material be moulded around it in the act of carbonization, there is an intimate union by combination and by pressure between the carbon and platinum, and nearly perfect contact is obtained without the necessity of clamps; that the burner and leading wires should be connected to the carbon ready to be placed in the vacuum bulb, and when fibrous material is used the plastic lamp black and tar should be used to secure it to the platina before carbonizing.

The specification proceeds as follows:

"By using the carbon wire of such resistance I am enabled to use fine platinum wires for leading wires, as they will have a small resistance compared to the burner, and hence will not eat and crack the sealed vacuum bulb. Platina can only be used, as its expansion is nearly the same as that of glass.

"By using a considerable length of carbon wire and coiling it, the exterior, which is only a small portion of its entire surface, will form the principal radiating surface; hence, I am able to raise the specific heat of the whole of the carbon, and thus prevent the rapid reception and disappearance of the light, which on a plain wire is prejudicial, as it shows the least unsteadiness of the current by the flickering of the light, and if the current is steady the defect does not show."

The specification then gives direction for carbonizing the carbon thread in a manner to prevent its distortion, for blowing a glass bulb ever it after it is formed, for exhausting the glass bulb, and for hermetically sealing the bulb when a high vacuum has been reached.

The claims are as follows:

"1. An electric lamp for giving light by incandescence, consisting of a filament of carbon of high resistance, made as described, and secured to metallic wires, as set forth.

"2. The combination of carbon filaments with a receiver made entirely of glass and conductors passing through the glass, and from which receiver the air is exhausted, for the purpose set forth.

"3. A carbon filament or strip coiled and connected to electric conductors so that only a portion of the surface of such carbon conductors shall be exposed for radiating light, as set forth.

"4. The method herein described of securing the platina contact wires to the carbon filament, and carbonizing of the whole in a closed chamber, substantially as set forth."

The specification is addressed to those who were skilled in the art to which it relates; who appreciate the advantages of arranging incandescent lamps in a system of multiple arc, and of providing the lamp with a burner of high resistance and small radiating surface; who knew how high resistance, both specific and total, is imparted to a conductor; who knew that the rods, pencils, or other forms of carbon burners previously used had not been designed to embody the principle of high resistance; who knew how desirable it was to maintain the burner in a perfect vacuum, or in gases that would exclude the oxygen; who knew what had been attempted and had proved impracticable in that behalf; who knew that such materials as are mentioned in the specification (even the tar putty compound seems to have been used by some) would compose a carbon of high resistance when subjected to a proper process of carbonization; and who knew how to practice proper processes for the carbonization of such materials.

Read by those having this knowledge the radically new discovery disclosed by the specification is that a carbon filament as attenuated before carbonization as a linen or cotton thread, or a wire seven one-thousandths of an inch in diameter, and still more attenuated after carbonization, can be made which will have extremely high resistance and be absolutely stable when maintained in a practically perfect vacuum. It informs them of everything necessary to utilize this discovery and incorporate it in a practical lamp. It describes, with the assistance of the recital in the second claim, as the vacuum in which the burner is to be maintained a bulb made wholly of glass, exhausted of air, sealed at all points by the fusion of the glass, and in which platinum leading wires are sealed by the fusion of the glass. It describes the materials of which the burner is to be made and instructs them that the materials are to be shaped into their ultimate form before carbonization. It describes the use of platinum for leading wires, and a method of securing the leading wires and filaments, intending this dispense with clamping, which consists in molding tar putty about the joints, and carbonizing the whole in a closed chamber. Besides stating that the resistance of the burner will be greatly increased and the radiating surface still be kept within moderate limits by coiling it in the form of a spiral, the specification states that by increasing the length of the filament, which can be done only will be the principal radiating surface, and greater steadiness of illumination will be promoted.

The first claim must be read with several limitations. The filament is to be made of carbon of high resistance; that is, as the experts agree, of high specific resistance. The filament is to be made as described; that is, the materials are to be of some of the kinds described, and are to be shaped in filamentary form and then carbonized. The

filament is to be secured to metallic wires according to the method of the patent, because the claim implies the elements of a globe and metallic conductor arranged in circuit with the burner, otherwise the combination would not be operative and it would have been needless to specify the securing of the metallic wires to the filament, unless it was intended to import into the claim the specific method of doing so emphasized in the specification.

The defendant does not infringe this claim, if for no other reason, because the leading wires in its lamps are not secured to the filament according to the method of the patent; that is, by cement carbonized *in situ*, and by clamps such as the specification condemns.

The second claim is broad enough in its phraseology to secure the real invention described in the specification, and can be read consistently with its language so as to import into it every essential limitation.

It was a remarkable discovery that an attenuated thread of carbon would possess all the long-sought qualities of a practical burner when maintained in a perfect vacuum. The extreme fragility of such a structure was calculated to discourage experimentation with it, and it does not detract in the least from them the originality of the conception that previous patents had suggested that thin plates or pencils or small bridges could be used. The futility of hoping to maintain a burner in vacuo with any permanency had discouraged prior inventors, and Mr. Edison is entitled to the credit of obviating the mechanical difficulties which disheartened them, but what he did in this respect was a matter of only secondary merit and was no longer new in the art, because he had already disclosed it in his French and English patents. What he actually accomplished was to unite the characteristics of high resistance, small radiating surface and durability in a carbon conductor by making it in a form of extreme tenuity, out of any such materials as are mentioned in the specification, carbonizing it, and arranging it as he had previously arranged his platinum burner in an exhausted bulb made wholly of glass and sealed at all points, including those where the leading wires entered, by the fusion of the glass.

He was the first to make a carbon of materials and by a process which was especially designed to impart high specific resistance to it—the first to make a carbon in the special form for the special purpose of imparting to it high total resistance, and the first to combine such a burner with the necessary adjuncts of lamp construction to prevent its disintegration and give it sufficiently long life. By doing these things he made a lamp which was practically operative and successful, the embryo of the best lamps now in commercial use, and but for which the subdivision of the electric light by incandescence would still be nothing but the *ignis fatuus*, which it was proclaimed to be in 1879 by some of the learned experts who are now witnesses to belittle his achievement and show that it did not rise to the dignity of an invention.

The coiled form of the burner is only an alternative feature, and is not a constituent of the second claim. It is the subject of the third claim. Nor is the bent form or any form other than the filamentary. It may be that in the haste which has always seemed to characterize Mr. Edison's efforts to patent every improvement, real or imaginary, which he has made or hoped to make, he had not stopped to reflect when he framed his application for the patent that the filamentary burner would do its work just as well uncoiled as coiled, provided the same length and cross-section were used. It is true that it is said in the general statement of the nature of the invention that the burner is so "coiled or arranged" as to offer high resistance and present a small radiating surface; but this description is satisfied by any arrangement, whether by coiling a considerable length in a small globe or using the same length uncoiled in a larger globe, by which sufficient total resistance is obtained from a filament of small diameter. It certainly would not involve invention to omit the coiling and elongate the globe; hence, it is manifest that the invention described is the same thing essentially, whether the coiled form is used or not. The language is satisfied, if the burner is filamentary and so arranged as to offer great resistance and slight radiation, without importing into it anything which is not of the essence of the invention. No precise limitation upon the maximum diameter of the filament can be defined from the specification or is required as an element of the claim. The specification mentions, by way of illustration, the threads of linen or cotton which become more attenuated after carbonization, and the carbon wire which after carbonization would be from four to five one-thousandths of an inch in diameter; while the smallest rods of carbon previously known were about a millimeter in diameter, thus having a cross-section 50 times as great as the carbon wire. It is to be implied from suggestions in the specification that it is to have sufficiently high total resistance for efficient use when the lamps are arranged in multiple arc, and to be used with leading wires of fine platinum. The claim is not limited to a carbon filament made of non-fibrous material. The conductors of the claim are the platinum wires mentioned in the specification. The receiver is the vacuum described in the specification. The peculiar method of securing the conductors to the filament, made a constituent of the first claim, is not imported into the second claim. A more exact interpretation of the meaning of the claim than has thus been indicated is not necessary in the present case, because each of the three lamps representing the kinds used by the defendant embodies the invention of the claim as thus interpreted.

It is of little import what Mr. Edison, or his patent solicitor, may have thought about the meaning of the claim during the pendency of the application for a subsequent patent, or that Mr. Edison may have supposed a resistance as high as 100 ohms in the burner would be required for use with the means of distribution which he expected to employ with his system of lighting. There are many adjudicated cases in which it appears that the inventor builded better than he knew; where a patent has been sustained for an invention the full significance of which was not appreciated by the inventor when it was made. In the case of the Bell Telephone patent there was great room for doubt whether the speaking telephone had been thought of by Mr. Bell when he filed his application for a patent, but the court said: "It describes apparatus which was an articulating telephone, whether Bell knew it or not" (22 Blatch., 535).

The nearest approach in the prior art to the invention of the second claim is undoubtedly the lamp of Edison's French and English patents with a platinum burner. It seems almost preposterous to argue that the substitution of the carbon filament for the platinum burner of that lamp was an obvious thing to electricians. It would have been, probably, if there had been such a thing as a filamentary carbon in the prior art. But the nearest approximations to it were the ribbon-shaped carbon burner of low resistance of Mr. Farmer (which was not a part of the prior art, but an isolated example known only to a select few) and the low resistance carbon rod burners of the patent of Sawyer & Man.

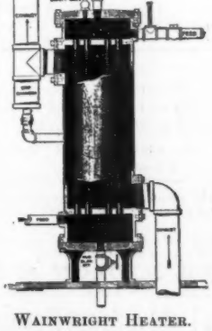
Undoubtedly, the improvements that have been made in the art, such, for instance, as the method of electrical carbonization of the filament, since Mr. Edison's invention, have been of great value, and the perfected commercial lamp of to-day is far superior to the one which could be made by applying to the description of the patent all the knowledge and skill then possessed by those to whom it was more particularly addressed. But, as was said by Bowen, L. J., in the Court of Appeals in England, "The evidence shows that lamps made solely on the patent will and do succeed, although subsequent improvements have been ingrafted on the original design." It is impossible to resist the conclusion that the invention of the slender thread or carbon as a substitute for the burners previously used opened the path to the practical subdivision of the electric light.

The questions which have seemed the most meritorious of those argued at the bar have now been considered. Others, to which no reference has been made, have not been overlooked, and may be dismissed without discussion, and with the single remark that nothing which has been presented by the voluminous proofs and the exceedingly able and elaborate arguments of counsel seems to supply any valid reason for refusing to decree for the plaintiff.

The usual decree for an injunction and accounting is accordingly ordered.

The Wainwright Water Tube Heater.

The Wainwright Manufacturing Company of Massachusetts has recently put upon the market the water tube heater illustrated herewith. It is of the straight tube type, the tubes being made of corrugated copper, and is provided with a settling chamber and surface blow. The points aimed at in the construction of this heater have been to manufacture a first-class device at a reasonable price. One of the great advantages of a straight tube heater is that with proper means of blowing it off it gives a chance for the impurities of the water to settle and be disposed of, thus avoiding the chances of fouling and burning out the boiler. The



WAINWRIGHT HEATER.

corrugated tube completely absorbs any expansion and removes the danger of leaks which would otherwise take place. There are about 250,000 horse-power of this company's heaters in operation to-day.

LITERARY.

"Reports From the Consuls of the United States," May 1891, has been received.

"Hewlings' Directory of Steam Specialties and Engineering Appliances," for 1891, is the first issue of a valuable trade directory. It is a small, neatly bound volume, giving quite complete data on the subjects indicated in the title. A. J. Hewlings, Chicago, is the publisher.

NEWSPAPER ADVERTISING.

From the Investor's Point of View.

SECOND OF A SERIES OF ARTICLES ON THIS IMPORTANT BRANCH.

This week Mr. C. M. Wilkins, of the well-known and old established house of Partrick & Carter Company, Philadelphia, has some good words and true to tell.

TO THE EDITOR OF ELECTRICAL REVIEW:

When looking over the pages of the electrical journals of the present day my thoughts revert to the past and to those days when the volume and variety of our business was very much less than it is now, and advertising bills were but a small item of the expense account; not because of any disinclination to advertise, but owing to the fact that the mediums that could be used were few in number. My experience with the advertising columns of periodical publications devoted to the interests of our business dates back to the days of *The Telegrapher* and *The Operator*, monthly papers published for the benefit of the telegraphic fraternity, and from their ranks, it may be said in passing, have risen many of the brightest lights in the electrical world of to-day. Those who are so fortunate as to possess copies of the papers named dated along in the early seventies will find food for reflection in a comparison with the electrical journals of this time. Surely no greater proof of the rapid and wonderful growth of electrical industries could be brought forward, than the changes and improvements which have taken place in this branch of modern journalism. We used the advertising columns of *The Telegrapher* and *The Operator* to inform their readers that we made and sold telegraphic apparatus, the trade term "electrical supplies," as it is now used, being then unknown.

MR. C. M. WILKINS,
OF THE PARTRICK & CARTER COMPANY, PHILADELPHIA.

Those who were among the pioneers in electrical journalism will remember that the advertising department was a secondary consideration, and the number of advertisers limited, there being only a few concerns in this country engaged in the manufacture and sale of telegraphic supplies. Many of the firms whose advertisements were to be seen at that time have long since gone out of business, while others are still active in the trade and their announcements will be found week after week in the journals now published. In addition to these old-timers, the advertising pages are used to-day by a host of manufacturers, electricians, engineers, contractors and dealers in various supplies and specialties representing kindred and allied interests, all making up what is now known as the electrical supply trade. This term covers a wide field which can the more easily be appreciated when it is remembered that this branch of American industries alone has in 10 years made good salaried positions for considerably more than a quarter of a million persons, to say nothing of the vast army of laboring people who have found employment in some department of electrical work. Having in mind the importance of this large and growing trade, it is plain to be seen that if the business man of to-day wants to "be in it," he must advertise.

As to methods, an advertiser ought to be influenced by his individual judgment, experience and results, and no one man therefore is qualified to set up a standard or establish rules for an ideal system or method of advertising that all could follow with the certainty of achieving success. What is here stated is based on personal experience and observation, and the excuse for its publication is that the Editor asked for it.

I believe in generous advertising, in so far as it refers to using every good medium which can be found, and I never look upon the advertising solicitor as an unwelcome visitor. On the contrary, I am pleased to see him, and if he can convince me that he has something that will advance the interests of our business, I will use it. If my judgment leads me to believe that the medium presented is not adapted to our needs, then I frankly and quickly tell him so, and thus save his time as well as my own. After deciding to make use of a particular medium, the plan I generally adopt is to keep a standing card in that paper, so that our advertisement will become a regular fixture, and be looked for by the reader with the same interest that he refers to any other special feature; that being the case, when he wants anything in our line the chances are all in favor of his corresponding with us and thus opening up a way to future business. We have been advertisers with most of the electrical papers since their first issues, and while differences of opinion have at times caused us to discontinue our relations with some publishers for a time, such a course has been the exception; our rule is, "Once in—Stay in." I also believe in having the advertisements in all the papers used as nearly alike as possible in wording, space and general make up, unless we have something special to which we desire to call attention; in such cases this is made as an extra announcement.

It must be understood that I do not claim for the foregoing that it is in any way entitled to the dignity of being called a system, but it is the method which has always brought us the most satisfactory results, and while it has never been my experience to trace many sales to any particular advertisement, whether because the mediums used were not good ones, or our correspondents failed to "confer a favor on both the advertiser and publisher, etc.," I am unable to say. Nevertheless, I confidently believe that if all our advertisements were withdrawn we would soon realize that advertising does pay, and if I was asked to offer a sentence that might be considered worthy of remembrance it would be this. "If you want to drop out of business—drop out of the papers." Yours truly,

C. M. Wilkins

Philadelphia, July 18, 1891.

The Lynn & Boston Horse Railroad, which is to adopt electricity on its line between Lynn and Boston, Mass., is reported to have placed an order with the Westinghouse Electric and Manufacturing Company for three railway generators of 125 horse-power capacity. Each machine will deliver a current of 500 volts and 900 amperes, and as the dynamos are to be connected in parallel, the current employed to operate the cars will have an output of 500 volts and 2,700 amperes. Forty-five gearless motors have been ordered, each of 20 horse-power, and two will be applied to each car.

KINDRED INTERESTS

The Law Telephone Company, 85 John street, New York, recently received from Hamburg 10 casks of sal ammoniac, 99.85 per cent. pure.

The 1891 Electric Motor and the 1891 electric battery are described and illustrated in catalogue A, issued by O. A. Foster, general selling agent, 8 Oliver street, Boston, Mass.

The Ball & Wood Company, New York, have just issued a very handsome and artistic catalogue of the improved Ball automatic cut-off engines. A product as good as the Ball engine is worthy the time and expense involved in the preparation of a handsome catalogue.

The Wisconsin News Company, a branch of the American News Company, commenced business July 13, at No. 298 East Water street, Milwaukee, Wis., under the management of Mr. Abraham Bancker. The ELECTRICAL REVIEW may be secured through this company at all times.

Robert A. Keasbey, 58 Warren street, New York, has opened a branch office at 119 Franklin street, Buffalo, N. Y., for the sale of his famous magnesia sectional pipe covering. A full line of stock will be carried. Mr. Keasbey has about finished covering the pipes in the Buffalo Street Railway power house, and will immediately begin work on the piping in the Hotel Iroquois, Buffalo.

Mr. W. R. Mason, general manager of the Electric Merchandise Company, Chicago, reports that his company is negotiating with several of the prominent steam railroads for the introduction of the Burton electric heater on the limited Pullman trains. Mr. Mason also says that the Merchandise Company is doing all the electric railway business it can handle. Notwithstanding a recent large increase in the working force, a great deal of overtime work on the part of the company's employés has been necessary.

The Empire City Electric Company, New York, having gone into voluntary dissolution, Mr. C. S. Beardsley has been appointed receiver by the Supreme Court, and is engaged in winding up the affairs of the corporation. It being the desire of all parties in interest to close up the business with little delay, Mr. Beardsley is disposing of the stock on hand on favorable terms. The stock is large and embraces almost everything in the line of general electrical supplies, including house furnishing, telephone, telegraph, electric light and power goods, construction tools and medical apparatus.

The Central Electric Company, Chicago, have recently taken some very large orders for electroliers and other electric light fixtures for several public buildings in the Northwest. They report a large trade on these articles, and that the demand is constantly for better goods than have heretofore been supplied. At a recent life test of 100 Packard lamps by a superintendent, the average life was found to be 2,113 hours. The Central Electric Company are handling these lamps in the West and report that their sales are constantly increasing, and that the capacity of the factory is now being doubled to meet this new demand.

The New Works of The Berlin Iron Bridge Company, of East Berlin, Conn., are now completed; the company have all the machinery placed and are now running full time, employing in all departments 400 men. The new shop in Cromwell is said to be one of the most complete and perfect bridge shops in this country. The building is made entirely of iron, no wood-work being used about the construction, except for the window sash. The roof trusses are all provided with trolley cars with which to move material back and forth about the building, and three lines of narrow gauge tracks extend the entire length of the building, these three tracks being connected at each end of the building by a transfer table. There is a skylight on each side of the roof, extending the whole length of the building, and for a distance of 10 feet down from the eaves of the building on all sides, it is made entirely of glass, so that the interior of the building is thoroughly lighted. The company have purchased a large amount of new machinery, and are now prepared to furnish all kinds of structural iron work, including iron buildings, iron roofs and iron bridges, on very short notice, and with their improved facilities it seems as though they should be able to furnish this class of work as cheap as any other company in America. Their large experience in this class of work, and their improved facilities, insure first-class work at a reasonable price.

FOR SALE.

One 120 horse-power Rice Automatic Engine, in first-class order; in use about one year.

CITIZENS' ELECTRIC LIGHT COMPANY, GOSHEN, IND.

THE LAW

Double Cylinder Battery.

Surface of negative element and quantity of solution double that found in any other open circuit cell.

Weigh carefully these advantages.

Its sale has steadily increased for ten years.

LAW TELEPHONE CO.,

Sole Makers,

87 JOHN STREET, NEW YORK.

MACHINERY IN STOCK.

Engine Lathes, 10 in. x 4 ft.; 11 in. x 5 ft.; 12 in. x 6 ft.; 14 in. x 6 ft.; 16 in. x 6 ft.; 18 in. x 8 ft.; 30 in. x 8 ft., with tapes attachment; 22 in. x 12 ft. and 14 ft.; 24 in. and 26 in. x 16 ft.; 30 in. x 10 ft. and 18 ft.; 36 in. and 38 in. x 20 ft.; 42 in. x 12 ft.; 56 in. x 18 ft.; 72 in. x 20 ft.; 108 in. x 22 ft. Fox Lathes, 13 in. x 5 ft.; 14 in. x 5 ft.; 15 in. x 6 ft.; 18 in. x 6 ft. Turret Lathes, 12 in. x 5 ft.; 14 in. x 5 ft.; 15 in. and 16 in. x 6 ft.; 18 in. x 6 ft.; 36 in. x 8 ft.

Planers, 16 in. x 16 in. x 3 ft.; 20 in. x 20 in. x 4 ft.; 24 in. x 24 in. x 6 ft.; 30 in. x 30 in. x 6 ft.; 36 in. x 36 in. x 10 ft.; 42 in. x 42 in. x 12 ft.; 72 in. x 60 in. x 15 ft.; 72 in. x 60 in. x 20 ft.

Friction Shapers, 15 in., 16 in., 20 in., 22 in., 32 in.

Crank Shapers, 6 in., 8 in., 10 in., 12 in., 15 in., 16 in., 20 in., 24 in., 28 in.

Screw Machines, Nos. 1, 2, 3, 4, with or without Wire Feed.

Screw Machines, Nos. 5, 6, 7, 8, Power Feed.

Presses, Nos. 51, 52, 53, Ferracute, Nos. 1, 2, 3, Stiles & Parker.

20 Lincoln Pattern Millers, No. 2.

Hand Millers, Nos. 1 and 2. 3 Cam Cutters.

Bolt Cutters, ¼ in. to 1 in., ¼ in. to 2 in.

2 Profiling Machines. 1 36 in. and 48 in. Gear Cutter.

1 New Horizontal Boring Machine. Newark Machine Tool Co.

Send for List of New and Second-Hand Machinery in Stock.

PRENTISS TOOL & SUPPLY CO., P. O. Box 3362.

115 Liberty Street, New York.

— THE —

REMINGTON

Standard Typewriter.

Presents the practical results achieved by the best inventive and mechanical skill, aided by capital and the experience gained during the FIFTEEN YEARS in which it has been the

STANDARD WRITING-MACHINE OF THE WORLD!

Send for Illustrated Catalogue.

Wyckoff, Seamans & Benedict,

327 BROADWAY, N. Y.

PATENT PERFORATED

ELECTRIC

LEATHER BELTING

MANUFACTURED BY

Charles A. Schieren & Co.,

45, 47, 49, 51 FERRY ST.,

COR. CLIFF ST.

BRANCHES:

BOSTON, 119 HIGH STREET.

PHILADELPHIA, 226 NORTH 3d STREET.

CHICAGO, 46 SOUTH CANAL STREET.

"A BIG HIT!"

AN ADJUSTABLE HAMMER

WE CLAIM this is the Best, Cheapest, Loudest Ringing and Handsomest Electric Bell in the United States.

WRITE FOR PRICES.

(Patent Applied For.)

HAY-HORN MFG. CO.,

63 South Canal Street,

NEW CATALOGUE READY. CHICAGO.

Eastern Agt., Jas. H. Mason, 120 Park Ave., B'klyn, N. Y.

JEWELS for scientific purposes. Sapphire and Agate Galvanometer Jewels. Sapphire Dies and Cutters for Fibres.

JOHN WENNSTROM,

COR. JOHN AND DUTCH STREETS, NEW YORK.

IF YOU have anything pertaining to electric machinery you want to sell, send us the description.

IF YOU want anything pertaining to electric machinery, send us your inquiries.

FRANK RIDLON & CO.,

Dealers in New and Second-Hand

Electric Light & Power Machinery,

196 SUMMER STREET, BOSTON.

THE ELECTRICAL ENGINEERING COMPANY,

Contractors for Complete Arc, Incandescent and ower Plants.

ROOM 603, MONON BLOCK, 320 DEARBORN ST., CHICAGO, ILL.

Superintending Electrical Construction, and Advice on Electrical and Mechanical Subjects a Specialty.

"Magnetic Vane" Ammeters and Voltmeters.

THE best and cheapest instruments for Central Stations, Isolated Plants, Marine Installations and Electric Railways. Special Contracts made with Manufacturing Companies for supplying Ammeters and Voltmeters for use with their plants.

Correspondence Solicited.

Send for Descriptive Circular 235, and Catalogue I-66.

QUEEN & CO., Makers, Philadelphia.

ELECTRICAL PATENTS

INDEX OF INVENTIONS FOR WHICH LETTERS PATENTS OF THE UNITED STATES WERE ISSUED ON JULY 14, 1891.

455,763 Subway and connection for electric railways; William Osner, Chicago, Ill.

455,765 Electric motor; Harry H. Porter, New York, N. Y.

455,773 Alternating current motor; William Stanley, Jr., Pittsfield, Mass., and John F. Kelley, New York, N. Y.

455,788 Thermostat; Henry A. Chase, Boston, Mass.

455,789 Process of manufacturing insulated conductors; Charles Cuttriss, New York, N. Y.

455,790 Dynamo-electric machine or motor; Justus B. Entz, New York, N. Y.

455,796 Electric railway; Rudolph M. Hunter, Philadelphia, Pa., assignor, by mesne assignments, to the Thomson-Houston Electric Co., Boston, Mass.

455,798 Trolley for electric cars; Walter H. Knight, Newton, Mass.

455,800 Electric cut-off apparatus. 455,807 Armature for dynamo-electric machines; Edwin W. Rice, Jr., Lynn, Mass., assignor to the Thomson-Houston Electric Co. of Connecticut.

455,808 Electro magnetic ore separator. 455,809 Magnetic separator; Jonas Wenström, Orebro, Sweden, assignor, by direct and mesne assignments, of two-thirds to Olof Wenstrom and William W. Manning, Marquette, Mich.

455,813 Thermostat; Henry A. Chase, Boston, and Howard F. Eaton, Cambridge, Mass.

455,815 Electro-phonometer and phonoscope; Isaiah H. Farnham, Wellesley, assignor to the New England Telephone and Telegraph Co., Boston, Mass.

455,837 Electric switch; Carl G. Dahlgren and John H. Svensson, Gothenburg, Sweden.

455,855 Electric indicator; Earl C. Eldredge, Springfield, Mass.

455,856 Holder for carbon brushes or commutators; Clarence H. Farrington, Milford, Mass.

455,873 Signaling apparatus; Howard F. Eaton, Quincy, assignor to George W. Gregory, Boston, Mass.

455,898 Electric motor or dynamo-electric machine; Charles G. Curtis, New York, N. Y.

455,904 Insulated electric conductor; Elihu Thomson, Swampscott, Mass., assignor to the Thomson Electric Welding Co., of Maine.

455,953 Cut-out for arc lamps; Charles E. Scribner, Chicago, Ill.

455,955 Lightning arrester; Charles S. Van Nuis, New Brunswick, N. J., and Jonathan H. Vail, New York, N. Y.

455,956 Electric railway system; Samuel P. Wilcox, Elkhart, Ind., and Joseph D. Partello, Rochester, Mich.

455,968 Secondary battery plate; John R. MacLaughlan, Philadelphia, Pa., assignor to Simon Miller, same place.

455,971 Armature for dynamos; Frederick L. McGahan, Indianapolis, Ind.

455,972 Electro-medical lighting apparatus; Paul Oudin and Henri O. Kratz-Boussac, Paris, France.

455,981 Apparatus for administering electricity; George H. Bethel, Sydney, New South Wales, assignor to the Bethel Electric Medical Baths Co., Limited, Melbourne, Victoria.

455,984 Magnetic separator. 455,985 Magnetic ore separator; Henry G. Fiske, New York, N. Y., assignor to John D. Chesver, same place.

455,986 Terminal for electric batteries; Hammond V. Hayes, Cambridge, Mass., and Angus S. Hibbard, Morristown, N. J., assignors to the American Bell Telephone Co., Boston, Mass.

456,021 Electric belt; Lewis N. Fancher, Kansas City, Mo.

456,023 Railway time signal; Joshua C. Dickover and Walter Scott, Hot Springs, S. D., assignors of one-half to Joseph B. Dickover and Charles G. Fargo, both of same place.

456,103 Motor truck for elevated railways; Ephraim M. Turner, George L. Van Beek and Lewis A. Brown, St. Louis, Mo., assignors to the National Unicycle Elevated Railway Construction Co., East St. Louis, Ill.

Address, for Circular of Styles and Prices,

JARVIS B. EDSON,

87 LIBERTY STREET, NEW YORK.